

## **Stones of Rio de Janeiro in its Built Heritage**

**Nuria Fernández Castro**  
Centre for Mineral Technology – MCTIC

**Kátia Leite Mansur**  
Geology Dep./Fed. Univ. of Rio de Janeiro – UFRJ

**Maria Heloísa Barros de Oliveira Frasca**  
MHB Serviços Geológicos Ltda.

### **Abstract**

**This paper aims at bringing attention to the necessity of interdisciplinarity of architectural and heritage conservation projects, specifically regarding the historical and current use of natural stones. Despite of being long lasting building materials, natural stones are affected by alteration processes, naturally, as they are exposed to the environment and more rapidly when in use, especially in urban areas. Their degradation patterns and rate depend also on their mineralogical composition and geological history, which is the main object of study of geologists. Being part of almost all the material cultural heritage, the proper knowledge of the building stones, their characteristics and source is fundamental to the success of conservation interventions and should be documented. Nevertheless, the lack of documentation on stones of the built heritage is a common issue around the world. To address this problem and raise awareness of the importance of natural stones characterization and documentation, the Heritage Stones Subcommission, of the International Union of Geological Sciences, established the Global Heritage Stone Resource designation for stones significant to the human culture. Most of the designated stones so far are from European countries, but in Brazil, particularly in Rio de Janeiro, there are stones whose significance deserve to be internationally recognized. This paper shows an overview of the most important stones of Rio de Janeiro, their widespread use, their relationship with the landscape of the city and its social and**

**urban development, and the urgent need to know and care for those stones to preserve the cultural heritage.**

[...] we resolved, with the help of science, a certain misunderstanding spread by some historians, that the cloister had been made with sandstone from Ilha da Boipeba [...] Well, who has some rudiment of geology does not see any sandstone in the cloister (except on the balcony sill) and even on Ilha da Boipeba there is no sandstone, as far as it is known! [...] we characterized the limestone that was there and was a dolomite.

—Mario Mendonça de Oliveira, *Sobre Pedra, Arquitetura & Restauro*, p.26

### **Introduction**

Stones have accompanied the development of almost all societies. Due to their local availability, beauty, and durability they have been used along human history as utensils, artworks, infrastructure works, paving, urban ornaments, building materials, etc. In other words, stones are witnesses of the social and cultural development of humankind. Their durability is stated by the enormous quantity of remains of old civilizations all over the world, especially in Asian and European countries. The monumental architectural site of Gobekli Tepe, in Turkey, for example, believed to be a place for cult and rituals, has monolithic limestone sculptures which have survived 11,000 years [1]. The undeniable beauty of natural stones is represented all over the world by sculptures, ornaments, old and contemporary floorings and coverings, such as the book match on Fig. 1.



Figure 1. Bookmatch of the Botanic Wave (natural quartzite, approximate dimensions: 6 m x 4 m). Photo: Petrus Mineração, Brazil (2020).

Their local availability has given us beautiful cities built on local stones as the Villamayor Sandstone of Salamanca (Spain) or the Marble of Carrara (Italy), though there are many other examples around the world. Stones are the physical support and memory of human culture in architectural and artistic works and to preserve this memory for the future generations, they must be properly valued and treated, meaning properly known. Today, more than 150 million tons of natural stones are produced yearly in the world, mostly to be used for flooring and covering. One third of that quantity is traded in the international market [2] competing with a wide range of other building materials (ceramics, wood, glass, artificial stones, cement-based products and so forth). Although the selection and specification of a stone is usually based on its aesthetic features, it should be improved by considering its natural characteristics, composition, texture (i.e., its mineral arrangement), and alteration degree [3]. It is especially important for the Built Heritage Conservation as many examples of unsuccessful interventions in historical buildings demonstrate [4].

### Natural Stones

Stones are natural resources, so their aesthetic and mechanical/technological characteristics are the result of a unique geological history that goes back to many million years ago and each

stone has its own. The stones we use and see have passed by many long-lasting transformations (of millions of years). The action of pressure, temperature, fluids, and many other factors, in a very specific underground environment (that can be several kilometers below the Earth's surface), determined the formation of the different minerals that constitute each specific rock.

Once the rocks are exposed to the surface and its environmental agents, they will be slowly altered: physical, chemical, and mineralogical changes occur, naturally.

Those changes are accelerated when the rocks are quarried, transported, shaped to be building stones, and employed in a built environment. This occurs particularly in urban areas where they are exposed to other physical, chemical, and biological agents that interact with the stones starting new alteration processes.

Consequently, to better use, maintain, and conserve architectural works in stone, the intimate knowledge of this natural building material is essential.

Unfortunately, it seems that this is not what has happened throughout history. The conservation of the built heritage faces the added difficulty of the lack of documentation of the stones used, their properties, and their source of origin, as occurred regarding the white marbles that were used in Brasília [5].

Also, the involvement of geologists, professionals that are familiar with natural stones, is not a usual practice among conservation interventions. Geologists would be assets when choosing the most appropriate treatments or replacement materials in order to prevent future damages, which would be fundamental to the intervention success.

To address this issue, the Heritage Stones Subcommission (HSS) of the International Union of Geological Sciences (IUGS), elaborated a geological standard, the Global Heritage Stone Resource - GHSR designation, for building and ornamental stones that have been significant in human culture. It gives the designated stones an international recognition that helps increase professionals and community awareness of natural stones in the cultural heritage. It also enhances international co-operation for the research and documentation of natural stone resources. The GHSR title provides visibility to such an important Earth's resource, present in almost all the heritage buildings and monuments. Their conservation is closely related to the knowledge of the stone nature, geological frame, sources, production history, behavior within the environment, and conservation practices [6].

### **Global Heritage Stone Resource**

Twenty two stones have been recognized as GHSR so far: Portland stone (UK), Petit Granite (Belgium), Larvikite (Norway), Podpéc Limestone (Slovenia), Hallandia Gneiss (Sweden), Carrara Marble (Italy), Villamayor Sandstone (Spain), Estremoz Marble (Portugal), Maltese Globigerina Limestone (Malta), Jacobsville Sandstone (USA), Lede Stone (Belgium), Welsh Slate (Wales), Piedra Mar del Plata (Argentina), Kolmården Serpentine Marble (Sweden), Lioz (Portugal), Alpedrete Granite (Spain), Bath Stone (UK), Macael Marble (Spain), Makrana Marble (India), Pietra Serena (Italy), Rosa Beta Granite (Italy), and Tennessee "Marble" (USA).

To obtain the GHSR designation, first detailed information of these stones had to be gathered and published in peer reviewed journals. Some of the requirements are geologic age, structural/tectonic setting, petrography, stratigraphic name, natural variability, technical characteristics, cultural relevance, account on active quarries, historical quarries, and decay patterns.

The IUGS Global Heritage Stone Resource (GHSR) designation is a useful title to promote

the sustainable use of natural stones worldwide and it could yield many social benefits through:

- Increasing awareness of natural stone and its positive attributes in terms of sustainability and regional economic development.
- Facilitating the preservation/restoration of existent stone heritage by using appropriate materials.
- Encouraging the safeguard of important heritage stone resources from subsequent sterilization when there is pressure for alternative development.
- Promoting the appropriate specification of stone in the same way that regional designation of foodstuffs has occurred in the European Union.

From the list of stone recognized as GHSR, few of them, though, are from emerging countries. For those countries, the recognition of building stones as GHSR can be an empowering tool for people in need of scientific knowledge. It would encourage them to take ownership of their cultural heritage and, consequently, support its conservation.

It can also enhance the social and scientific values of architectural works and generate economic resources through scientific tourism. Additionally, expanding knowledge about natural stones could improve their use and maintenance.

Since the Brazilian built heritage is mostly less than 500 years old, it has not been properly valued for its historical and cultural importance. The lack of documentation, especially regarding its building stones, is a common issue that needs to be addressed to avoid inadequate conservation practices. These improper practices could lead to a loss of heritage objects of great importance, which, within the Brazilian framework, are witnesses of an evolution marked by a worldwide cultural mixture.

### **Rio de Janeiro Heritage Stones**

Rio de Janeiro has a special relationship with its stones; the very ones that give the city the impressive natural beauty, noticed and admired by all visitors since its discovery by the European conquerors. Rio de Janeiro's coastal rock massifs in between the urban tissue, as they can be seen today, have an exceptional role in the urban and cultural development of the city, as the title of World Heritage Cultural Landscape, given by UNESCO in 2012 acknowledges [7]. Due to a complex geological evolution, that started with the agglomeration of the Gondwana supercontinent, more than 500

million years ago, Rio de Janeiro's geomorphology is composed by steep mountain peaks and low terrains by the sea. That beautiful landscape was, nonetheless, very difficult to occupy, as the low terrains were swampy. Therefore, from the first settlement of 120 Portuguese that defeated and expelled the French invaders from the Guanabara Bay, back in 1565, to the 13 million inhabitants megalopolis of today, some millions of tons of stones have been needed to landfill flooded areas, dry lagoons, divert and channel rivers, build bridges, defensive forts and ports, gain terrain to the sea, pave the streets, and construct houses and public buildings. It can be properly said that Rio de Janeiro has been built *around*, *on* and *with* the same stones of the Sugar Loaf and the Corcovado.

Gneisses and granites were quarried from almost all the Rio de Janeiro mountains. In the 18th and 19th centuries, the quarries shaped Rio's urban expansion by giving it materials and by physically interfering with it. Three types of gneisses (Fig. 2) were expressively used: the leucocratic gneiss, called Leptinito, white to yellow coloured and fine grained; the kinzigitic gneiss, Kinzigito, blackish with characteristic garnet megacrystals, quartz ribbons and frequent blue cordierite crystals; and the most iconic of all, the augen gneiss called Facoidal, with big feldspar crystals bordered by deformed layers of biotite looking like eyes and known as "the most carioca of rocks" [8]

Even some local diabase was used as cobblestones and as a substitute for the basalts of the Portuguese pavements [9]. The Candelaria Church is an example of the use of Leptinito and Facoidal gneisses (Fig. 3). Those stones were used widespread throughout the Rio de Janeiro city and Niterói, where they were also quarried, and in buildings and monuments of other Brazilian towns.

Despite the several huge urbanistic reforms carried out mainly in the 20th century, those stones can still be seen in the buildings all around the city, sometimes together with imported stones such as Lioz limestone from Portugal or Italian and French marbles. One example is the Cultural Center of the Electoral Justice, magnificent building with a basement of Facoidal gneiss harmonized with delicate marble works. The surroundings of this building, on the Primeiro de Março street, are full of Rio de Janeiro stones in buildings and pavement as it is all the harbor area (Fig. 4). There, the old stones of the city were



Figure 2. Up to down: Leptinito (Santa Luzia Church façade, downtown), Kinzigito (Praia Vermelha pavement, Urca) and Facoidal (Capanema Palace) gneisses of Rio de Janeiro. Photos: Nuria Castro (2020).



Figure 3. Columns of Facoidal gneiss (right) and Leptinito (left) of the Candelaria Church and Portuguese pavement. Photo: Nuria Castro (2019).



Figure 4. Old (waterfront wall) and new stones (pavement) at the Port of Rio de Janeiro. Photo: Nuria Castro (2019).

complemented with a new flooring of gneisses from the North of the State of Rio de Janeiro and from the State of Espírito Santo. It is interesting to note that, even being a recent reform, that from the New Port Area, it is exceedingly difficult to find information about the new stones used or their source of origin.

The old stones are also witnesses of the greatest world enforced human migration of all times that occurred, mainly during the 18th and 19th centuries, on the area around the Valongo Wharf (Fig. 5), the World Heritage Archaeological Site, uncovered in 2011. The old '*pé de moleque*' (peanut brittle) pavement of this slavery port is built mostly of Facoidal gneiss, probably from the adjacent Conceição Hill. After the official banishment of slave's trade, the area was enlarged and paved over twice in the 19th century: first as the Empress Wharf and afterwards as the Municipal Square. Another important rocky monument in that region, called Little Africa, as it represents the Afro-Brazilian cultural roots of the Rio de Janeiro inhabitants, is the Stone of Salt, where the "samba" was born. The Stone of Salt is an outcrop of Facoidal gneiss, part of the Conceição Hill over which slaves, freed or not, and other workers built their houses and carved a stair on the rock.

All kinds of Rio de Janeiro lithologies were used as cobblestones for the upper pavement of the Valongo Wharf, not just the three gneisses described in this paper. The characterization of

the stones of both pavements, ramp and stairs of the old harbors, which are also linked to the African continent by their geological history, and its divulgation are imperative to add scientific and social value to the site in order to guarantee the preservation of the memory of this dark stage of the world.

The use of the stones of Rio in buildings declined in the first decades of the 20th century, due to the city expansion and their substitution with concrete in which they were still used as aggregates. Nevertheless, their significance and cultural importance was acknowledged in the first modernist project of Brazil, the Gustavo Capanema Palace, by using Facoidal gneiss from one of the most important quarries, the Widow Hill Quarry, as representative of the Portuguese-Brazilian Architecture, together with Cândido Portinari's tiles, whose paint was produced replicating the old methods.

### Conclusion

Rio de Janeiro, as other cities around the world, was built and rebuilt with its local stones, the very same that give the city its wonderful landscape and influenced the Brazilian cultural development. Even so, and as it also happens in many of those other cities, they have been almost invisible within the heritage documentation, being referred in a generalized way, such as 'granites'.



Figure 5. The Valongo Wharf. World Heritage Site built with Rio de Janeiro stones. Photo: Kátia Mansur (2019).

There are so many visible old local stones in Rio de Janeiro as, sadly, so little information or documentation about them. This lack of proper documentation of such an important building material for the conservation of our cultural heritage, adds difficulties to the already hard work of preservation of our built memory. Rio de Janeiro stones are entitled to be designated as Global Heritage Stone Resources, due to their importance to the human culture. Architects, archaeologists and other conservation professionals, well versed on historic construction techniques and documentation research, should joint efforts with geologists that can and must help, by characterizing the stones and identifying sources, in this task of protecting our cultural heritage.

## Endnotes

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