

Characterization of Pegmatoid from Dimension Stones Tailings for Application as Ceramic Raw Material

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Abstract: Exploitation and processing of pegmatoids at Brazil's northeast (Serido region-RN State) aiming further use as dimension stone produces mass losses ranging between 30%-90%. The tailings are predominantly composed by feldspar, quartz, muscovite and other Fe-bearing silicates such as biotite and amphiboles, suitable for ceramic production. The recovery of these elements depends on mica's remotion to levels under 2.0%, preferentially by dry methods due the scarce amount of water prevailing at Serido region. This paper presents results from pegmatite tailings characterization from Serido region showing the potentially application as raw material for ceramic production. To do it, a new technological route must be developed to fit it as main component to white ceramic industry, considering the properties required by ceramic industries.

Key words: Tailings, dimension stones, technological characterisation, ceramics.

1. Introduction

Pegmatites an important natural source of chemical elements applicable in a large amount of industrial beneficiation processes [1, 2]. The term pegmatite can be used to design a rough-grained rock, containing as main constituent minerals of quartz, feldspar and muscovite. Kaolin, tantalite-columbite, garnet, spodumene, cassiterite and color gemstones also could be found in it [3-5]. The granitic bodies with textural variation between granite and pegmatites are assigned as "pegmatoides granite" or "homogeneous pegmatites" [2].

The granites and pegmatites are igneous rocks, the later being of hydrothermal origin, i.e., with the participation of water in its formation. The geological resource extraction in Brazil's northeast (Seridó region in the state-RN) has been developed to use it as dimension stone. These, include features such as

durability, low-cost of maintenance, great aesthetic and decorative effects suggest numerous possibilities of applications constituting, thus, an excellent choice of coatings for floors and walls, corresponding to about 70% of world production destined for this type of application [6]. However, the processes of extraction and processing shown in Fig. 1, which are mostly performed poorly is a huge amount of generated waste. The activities of exploitation and processing contribute to the generation of waste and its improper disposal compromises the environment. In recent years, there has been a concern of recycling the waste of small-scale mining for subsequent application in the ceramic industry. The use of these non-renewable mineral resources available is essential for the future of region that has as base his economy the mining activity. However, amounts of gangue minerals are found in order to restrict the application of these tailings in the ceramic industry. Therefore, this research aimed to technologically characterize the mine tailings of pegmatoides from Serido's pegmatite

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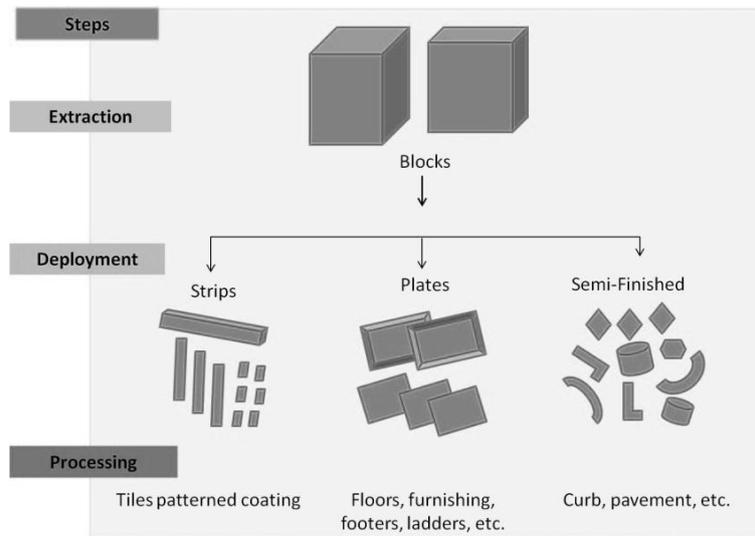


Fig. 1 Main transformations and products the ornamental rocks.

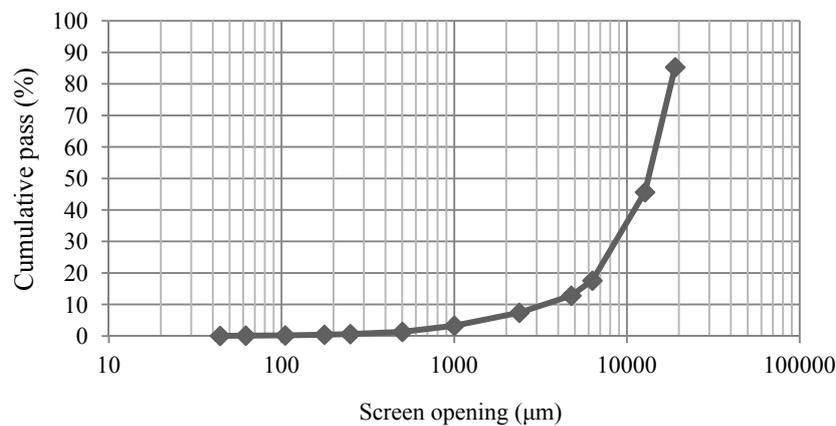


Fig. 2 Size distribution of pegmatoid tailing.

province aiming his use in white ware industry. Results of particle size distribution, chemical and mineralogical composition, degree of liberation of the muscovite mineral, fusibility and color burn are presented.

2. Materials and Methods

2.1 Sampling and Preparation

Visits were conducted to sample collection. They were analyzed at Mineral Processing Laboratory on Federal Institute of Education, Science and Technology of Rio Grande do Norte. The sample was crushed at jaw crusher, homogenized and quartered by cone method generating aliquots to analyze. Aliquots

were used to determine size distribution by sieving and liberation degree. Another fraction of samples were prepared to chemical, mineralogical and cone testing assays.

2.2 Samples Characterization

2.2.1 Size Distribution Assay

Size distribution was determined by wet sieving method using a series of sieves composed by the following Tyler apertures: 4, 8, 16, 32, 60, 80, 100, 150, 200, 250 and 325 (mesh).

2.2.2 Chemical and Mineralogical Analysis

Chemical analysis was performed by energy dispersive X-ray spectrometer Model EDX-720

Shimadzu at Mineral Processing Laboratory on Federal Institute of Education, Science and Technology of Rio Grande do Norte-IFRN and identified the oxides presented at the sample.

Mineral phases determination was performed by X-ray diffractomete Model XRD-7000 Shimadzu at Mineral Processing Laboratory on IFRN and identified the mineral phases presented at the sample.

2.2.3 Degree of Liberation

The *DL* (degree of liberation) allows to evaluate the amount of mineral of interest (in percent) that is completely free in a certain range of particle size [7]. This work used the method proposed by Ref. [8] that consists in a close examination of mineral particles in a narrow range. Particles ranging from 0.177 mm to 4.76 mm were analyzed. Average 200 particles were analyzed using a microscope Askania SMC 4 and the software J WCIF as a tool to aid to determine degree of liberation. After image analyzes, the degree of liberation was determined by Eq. (1).

$$\%DL = \frac{\text{free particles}}{\text{free particles} + \text{mixed particles}} \times 100 \quad (1)$$

2.3 Fusibility Test

The fusibility tests were performed in shaped cones that intended determine the material fusibility, burning color and water absorption. The cones were made with material's size smaller than 0.074 mm and burned in JUNG Model 0713 furnace at 1,240 °C. Water absorption was calculated using Eq. (2).

$$Aa = \frac{Mu - Ms}{Ms} \times 100 \quad (2)$$

where, *Aa* is water absorption. *Mu* and *Ms* are the wet weight and dry weight, respectively.

Table 1 presents the Brazilian Association of Manufacturers of Ceramic Tiles, Sanitary and Related Products-ANFACER (2002) ceramic groups and products accordingly water absorption levels.

Table 1 Classification of the ceramic to coating according to the water absorption (2002, ANFACER).

Groups	Water absorption (%)	Product
Ia	< 0.5	Stoneware porcelain
Ib	0.5-3.0	Stoneware
IIa	3.0-6.0	Semi-stoneware
IIb	6.0-10.0	Semi-porous
III	10.0-AA	Porous

3. Results and Discussion

3.1 Size Distribution

Fig. 2 showed the size distribution of pegmatoid tailings, indicating that 85.0% of the material is smaller than 19 mm.

3.2 Chemical and Mineralogical Analysis

The ceramic industry has many different requirements regarding the content of iron oxide present in their raw materials. When final product receives pigmentation, the iron oxides as Fe₂O₃ content tolerable range around 2%-3%. In other cases like white porcela in this content cannot be higher than 0.1%. Table 2 presents the chemical composition for that sample.

The sample's amounts of iron oxide make it suitable for ceramic production.

Feldspar is one of the main ceramic raw materials and acts as a flux during burning reactions, helping the formation of glass. Fig. 3 shows de mineralogical composition of pagmatoids tailings were identified the presence of the following minerals: albite, orthoclase, quartz and muscovite.

The presence of albite and orthoclase (feldspar) also

Table 2 Chemical composition the tailing pegmatoid sample.

Oxide	(%)
SiO ₂	71.81
Al ₂ O ₃	19.19
K ₂ O	4.17
Na ₂ O	2.88
CaO	1.37
Fe ₂ O ₃	0.33
MnO	0.21
Other	0.04

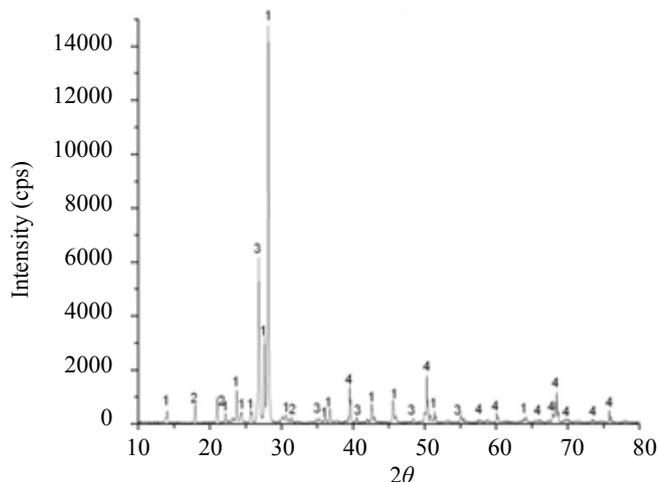


Fig. 3 Mineralogical analysis the sample of pegmatoid from northeastern Brazil. 1—Albite ($\text{Na (AlSi}_3\text{O}_8)$); 2—Orthoclase (KSi_3AlO_8); 3—Muscovite ($\text{KAl}_2(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH},\text{F})_2$); 4—Quartz (SiO_2).

make the material suitable for ceramic production. Muscovite by the other side is deleterious to ceramic processing and must be removed.

3.3 Degree of Liberation

The liberation and removal of the micas, that is deleterious to ceramic products, will allow the application of pegmatoids tailings as raw material to ceramic industry. Fig. 4 shows the results of degree of liberation to muscovite mineral on the following particle sizes: $-4.76 + 2.38$ (mm); $-2.38 + 1.00$ (mm); $-1.00 + 0.5$ (mm); $-0.5 + 0.25$ (mm) and $-0.25 + 0.177$ (mm).

The higher liberation rates were determined for particles sizes smaller than 2.38 mm. The muscovite is completely released from 1 mm particle's size.

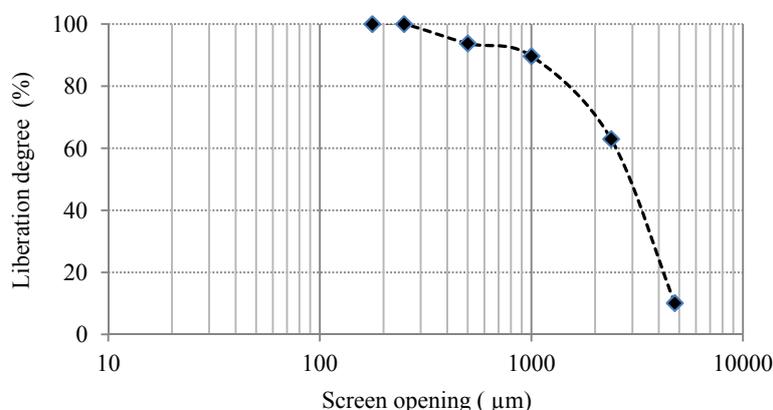


Fig. 4 Liberation degree the muscovite.

3.4 Fusibility Test

The test was conducted to determine the fusibility of the results show that this property could be classified as good, due his rough and glassy appearance after burning. The cones presented a beige color as can be seen in Fig. 5.

This color was obtained due the presence of iron oxide (Fe_2O_3) and titanium (TiO_2) in his composition [10]. In such a case, these pegmatoids tailings could be used to produce color ceramic with no changes at final product burning process.

The cones subjected to tests presented an average water absorption equals to 0.2% fitting the product as group Ia (stoneware porcelain) accordingly Table 2.

4. Conclusions

The tailings of dimension stones are mainly composed by albite, orthoclase, quartz and muscovite. All minerals but muscovite are used as raw materials for ceramic industry. To fit the sample to requirements of ceramic industry, the material must be reduced to particle size smaller than 2 mm.

The glassy and rough features indicate good fusibility. The color obtained after burning demonstrates the potential for further use of such tailings as raw ceramic materials, since muscovite could be reduced to levels below 2%.

The muscovite degree of liberation achieves 80% between 2.38 mm and 1 mm and 100% for sizes smaller than 1 mm. Minerals of interest also must be



Fig. 5 Test cone of the tailing of muscovite: Sintering temperature of 1,240 °C; Body of proof with dimensions of 3 cm diameter at the base and height of 2.5 cm, approximately.

Table 2 Classification of the ceramic to coating according to the water absorption (1997, ABNT).

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III	10.0-AA	Porous

liberated at this range.

The characterization results showed that it is possible to apply the tailings of dimension stone as white ceramic raw material within the requirements of the industry.

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