DEFECT CHARACTERIZATION OF THE RAW MATERIAL PHONOLITE USED IN STONEWARE TILE MANUFACTURE

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1 - ABSTRACT

The scope of the present study is to point out the defects that arise in fast-firing stoneware tile production and to provide some insights into the way to control them. More specifically, the subject of this study is a defect in ceramic tiles, which has been detected in Brazilian production industry. This defect has been associated with the use of phonolite.

Phonolite has been employed as a fluxing agent in the ceramic tile manufacture in Brazilian ceramic industries, because it displays excellent liquid-phase characteristics at the appropriate temperatures used in the fast-firing process.

The raw material used in the ceramic tile manufacture, known as phonolite, is a mineral mainly composed of feldspars, but it may contain pyroxenes, such as the phonolite from Lages, Santa Catarina, Brazil. These pyroxenes are the main cause of the defects addressed in the present work.

The importance of the Fonolite mine in Lages is its *50 km² extension* and its strategic location close to the biggest and most important ceramic complex of Brazil. This complex is responsible for 60% of the national ceramic production.

Feldspars are minerals found in 60% of the earth's crust and they can be divided in: alkali feldspars (group A, rich in K and Na) and plagioclases (group B, rich in Na and Ca).

Pyroxenes are mineral groups with Fe and/or Mg in their structure and easily accept isomorphic substitution.

2 - EXPERIMENTAL PROCEDURE

- CARACTERIZATION OF THE MATERIAL ➡ Scanning electronic microscopy, with EDX; X ray diffraction; Differential thermal analysis; Optical microscopy; Chemical analysis

- SIMULATION OF DEFECT ➡ Same industry parameters in which the defect is revealed critically;

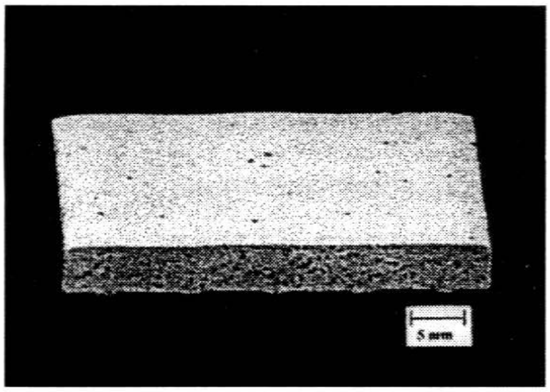
Different particle-size ranges used in each simulation group; Pyroxene particles introduced in the mass with 3,5 % by weight; Determination in which particle-size range the defect occurs, by introducing finer screens in the production line.

3 - RESULTS AND DISCUSSION

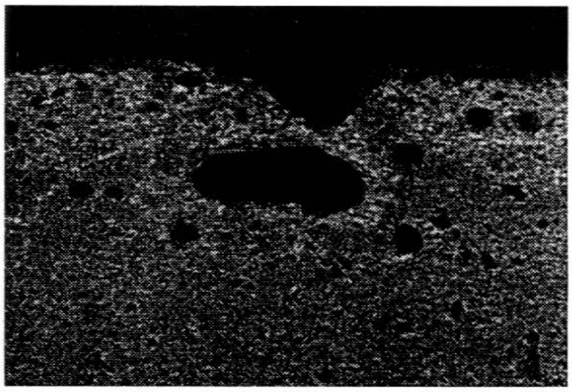
- **ORIGIN OF THE DEFECT** ➡ By SEM, EDX, XRD and STA

Phonolite {
- Pyroxenes - Aegerina/Augita solid solution - Origin of the defect
- Nepheline/Kalsilite solid solution
- Abite -
- Microcline

- **CARACTERISTICS OF THE DEFECT** ➡ Random distribution of dark points on the glaze surface; pinholes in the range of 200 to 500 μm diameter; critical appearance in bright and light glazes; defect origin in mass; medium periodicity; amplitude of 7% in production; critical intensity.



Defect simulation using pyroxene particles between 250 and 425 μm



Cross-sectional view of defect in product performed by SEM whit back-scattered electrons - magnification 64 X

- SIMULATION OF DEFECT

A defect simulation was performed to determine in which particle size range the pyroxenes found in the mass will cause defects.

The reason for selecting the particle-size variable was due to the fact that the use of this variable for defect control was easier to implement in the production line, especially because one of the stages of the manufacturing process was slurry screening after grinding.

The body formulation used in the defect simulation differed from the body formulation of the production line in respect of the phonolite particle size used in the body composition, plus the pyroxene particles introduced to provoke the defect.

Pyroxene particle-size range	Screen range (mesh)	Screen range(μm)	Defect occurrence
1	40 - 60	425 - 250	Yes
2	60 - 80	250 - 180	Yes
3	80 - 120	180 - 125	Yes
4	120 - 150	125 - 105	Yes
5	150 - 170	105 - 90	No
6	170 - 200	90 - 75	No

Table 3 - Results of the defect simulation in the production process

4 - CONCLUSIONS

The phonolite displayed proper characteristics for use as a fluxing agent in the fast-firing process.

The phonolite has albite, microcline and nepheline as major phases. Pyroxenes were also found, which were identified as aegirine and augite.

The high Fe concentration found in phonolite is due to the presence of pyroxene.

Phonolite from Lages, Santa Catarina, has particular characteristics, when compared with the literature, because of its composition and phases.

The defect studied originated in the ceramic body, when phonolite was used as a fluxing agent.

The defect occurs because of volumetric expansion and decomposition of carbonates, present in the pyroxenes.

The variables related with the occurrence of the defect are pyroxene particle size and the parameters used in the ceramic process.

It was verified that the defect only happened in the samples contaminated with pyroxenes particles bigger than 106 μm on average, with the process parameters used.