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Phyllite as feldspar substitute in porcelain stoneware tiles: effect on sintering behavior and phase composition

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The Brazilian porcelain stoneware tiles production is nowadays largely based on the use of phyllite: a fine-grained metasedimentary rock primarily composed of sericite, kaolinite and quartz. Due to its chemical and mineralogical composition, phyllite acts either as flux, plastic component or skeleton in a ceramic mixture. For this reason, Brazilian phyllite is widely employed in ceramic production, especially in the São Paulo area, thanks to its relative abundance in the Southern regions of Brazil. Despite the presence of phyllite in the ceramic body can reach 50% in weight, there is no detailed information about the firing behavior of this material. Moreover, even if phyllite is commonly used in substitution of fluxing component, no study on the effect of this replacement are available to date. In order to fill this knowledge gap, the sintering behavior of two porcelain stoneware batches was compared: one with 50%wt of phyllite – in total substitution of the feldspathic component of the batch – and a benchmark with 50% of K-feldspar. The two mixtures were characterized from the chemical point of view and their sintering behavior was determined in isothermal conditions by optical thermo-dilatometric analysis (TA ODP868). The isothermal tests were carried out at T_{md} (the temperature of maximum densification) with a heating rate of 80°C/min up to T_{md} and 30 min of soaking time. The quantitative phase composition was determined after firing at various temperatures (up to T_{md}) by XRD-Rietveld in order to calculate both the phases amount and the chemical and physical properties of the vitreous phase. Moreover, the high temperature permanent deformation of the tiles (pyroplasticity) was experimentally determined, in order to investigate the effect of the substitution of phyllite after K-feldspar. Pyroplasticity depends on the amount and the viscosity of the liquid phase, but also on the contribution of the crystals dispersed in the melt at the highest temperature. Therefore, viscosity values for the liquid phase and the whole tile were calculated on the basis of chemical composition and solid load, respectively. The results show that the substitution of feldspar by phyllite significantly reduces the pyroplastic deformation of the tile. This decrease is mainly due to the fact that the viscosity of the liquid phase formed by feldspar dissolution is considerably lower than that resulting from melting of sericite. Also the amount of liquid phase at the T_{md} is significantly higher in the feldspar-based body (73%wt) with respect to that of the phyllite-bearing mixture (62%wt).