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Study of citric acid dispersant in the settling behavior of slate powder suspensions

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ABSTRACT

The behavior of aqueous suspensions of slate stabilized with citric acid was investigated using sedimentation and rheological techniques. In order to determine the more effective dispersing agent concentration and the maximum loading of solids, a series of 12 suspensions were prepared with citric acid content between 0.5 and 2.5% *w*/*v* and solid percentages of 40, 55 and 70%. Light scattering techniques were used to obtain sedimentation data and particle size distribution; flow curves were obtained with a rheometer. The results indicated that the interaction between particle surfaces could either induce flocculation, at higher citric acid concentrations, or enhance the stabilization, at low dispersant concentration and pH values around 6. The highest sediment bed density was obtained for suspensions with 40% slate powder and 1.0% citric acid. This behavior was explained on the basis of the carboxyl groups of citric acid promoting higher dispersion of the particles resulting in lower settling rate, better stability and enhanced compact sediment bed.

1. Introduction

Brazil is the 2nd largest producer and exporter of slate, with Minas Gerais State accounting for about 90% of this production and almost all Brazilian exports. The production of slates in Minas Gerais totals approximately 500,000 tons/year, unfolding 18 million square meters of slabs, tiles, countertops, roofs and other products. (Feinar, 2006).

The system of extracting blocks of rock for the production of plates generates a significant amount of waste in the form of a sludge composed mainly of water, lubricants and crushed rock. This waste with no defined destination accumulates in yards, reservoirs and streams, affecting the environment. Generally, the waste amount is 25% of the production closed to 1.5×10^5 tons of tailings (Abirochas, 2012).

The waste generated by the extraction of slate as well as its processing can bring a series of impacts on the environment. Some industries use these rocks, after cutting and polishing them, for the production of ornamental rocks, which are, in turn, used in the construction industry.

The production of alternative materials having the waste generated in the manufacturing industries of rocks as constituents can reduce or even eliminate pollution in the extraction areas, apart from promoting new opportunities for jobs and income essential to the progress and development of the country.

The powder derived from the extraction of slate rock can be used in the manufacture of ceramic pieces by slip casting. The process, although quite old and simple, is currently used to make sanitary ware, sinks and crafts with a great variety of forms (Matias et al., 2011). Slip casting process route involves the use of thin powders (usually <1 μm) so that interfacial forces have considerable impact on the properties of the suspensions.

The interparticle forces involved in suspensions are governed by colloidal processing in order to obtain dense particle-packing and uniform microstructures (Moreno and Montes-Burgos, 2009; Sigmund et al., 2000; Lange, 1989; Palhares et al., 2006).

Colloidal processing offers the potential to reliably produce ceramic films and bulk forms through careful control of initial suspension “structure” and its development during fabrication. This approach involves five basic steps: (1) powder synthesis, (2) suspension preparation, (3) consolidation into the desired component shape, (4) removal of the solvent phase and (5) densification to produce the final microstructure required for optimal performance. Unintentional heterogeneities (or defects) introduced in any stage of the fabrication process persist or become exacerbated during densification. Hence, there is a continuous drive towards improved understanding of colloidal stability and assembly to achieve the desired spatial distribution of phases (including porosity) in as-consolidated bodies (Lewis, 2000).

The sedimentation processes of colloidal particle suspensions have been widely studied and used in many practical applications in ceramic processing (Lee et al., 2008; Argillier et al., 2002; Moreno and Montes-Burgos, 2009). The roles of particle–particle and particle–fluid

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interaction forces in the sedimentation process are of particular interest because of their function in determining the dispersion stability (Wasan et al., 2008) mainly in slip casting process, where the suspensions have high solids concentration.

Slip casting process requires stable suspensions, the characteristics of which are usually of crucial importance. The stability must be controlled in order to yield a final product with the best properties as well as to improve the economics of the process and to optimize energy requirements.

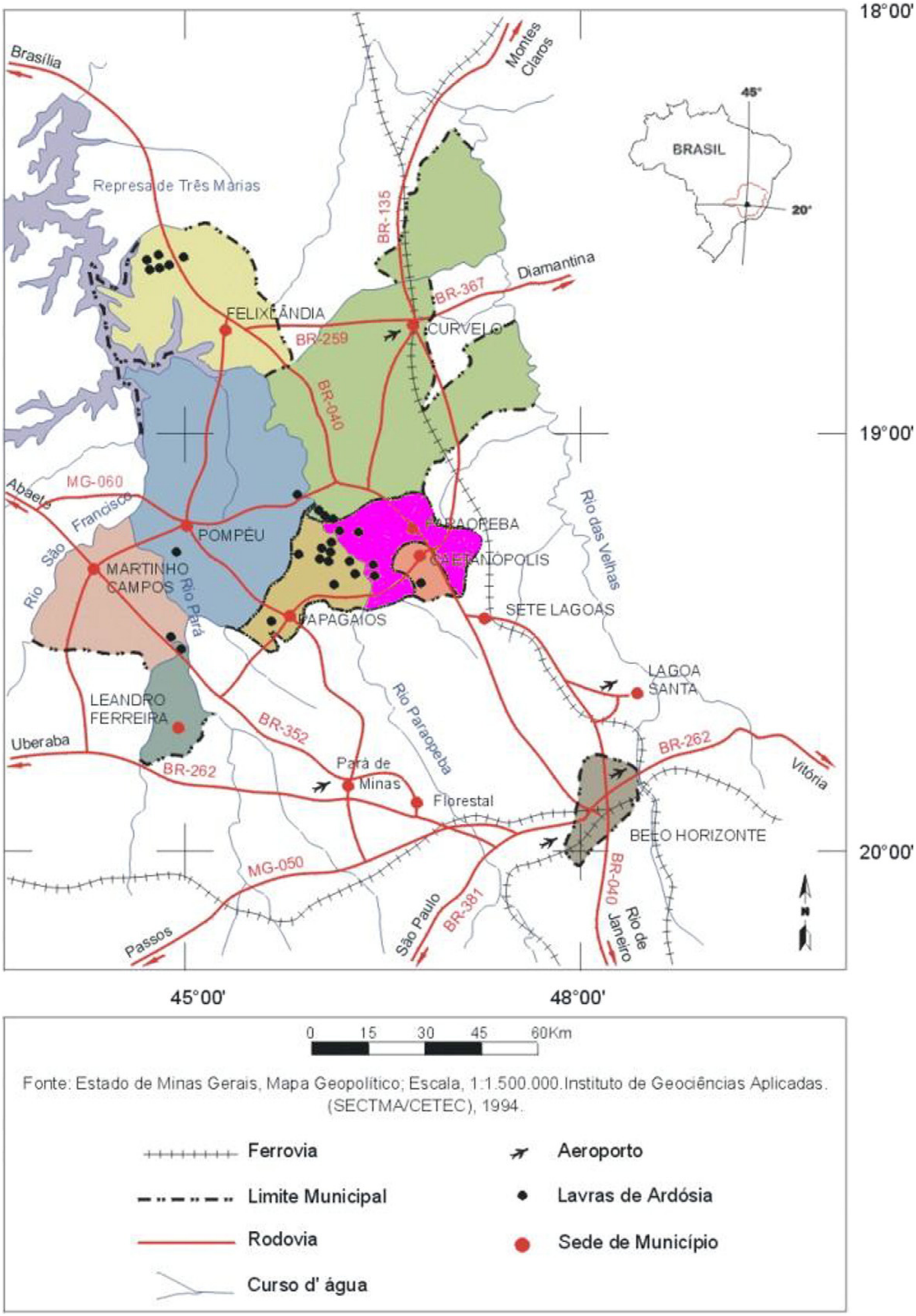

Fig. 1. Localization of slate production areas (Chiodi Filho et al., 2003).