

K-SILICATE AGROMINERALS FROM THE ULTRAPOTASSIC ROCKS OF THE BRAZILIAN CERRADO

ALBANO A. DA SILVA LEITE¹, MARCELO AUGUSTO DE OLIVEIRA², CARLOS ALEX LIMA ALVES³, MARIANA BASSETTO GABOS⁴, EDER DE SOUZA MARTINS⁵, RÔMULO SIMÕES ANGÉLICA⁶

^{1, 2, 3}TERRATIVA MINERAIS S.A, Bernardo Guimarães street, 245, 16th floor, Belo Horizonte, 30140-080, BRAZIL (albano.leite@terrativa.com.br¹, marcelo.oliveira@terrativa.com.br², carlos.alex@terrativa.com.br³); ^{4, 5}EMBRAPA Cerrados, BR 020 Km 8 Rod. Brasília / Fortaleza, Planaltina, 73310-970, BRAZIL (marianagabos@yahoo.com.br⁴, eder.martins@embrapa.br⁵); ⁶Programa de Pós-Graduação em Geoquímica e Geologia, Universidade Federal do Pará.

Introduction

Brazilian Cerrado soil is poor in macro and micronutrients. Despite Brazil being one of the top countries in agribusiness, Brazil has only one producing potash mine so that more than 90% has to be imported. This very uncomfortable dependence also has a significant impact on the country's trade balance. Due to actual low potash market prices, it is unlikely that any significant new production capacity will be developed in Brazil from the local potash salt deposits.

Embrapa is the leading Brazilian research institute for agriculture and to change the Brazilian dependence on imported potash, strongly supported the amendment 12,890 (2013) to the Brazilian Fertilizer Law 6,894 (1980), thus defining officially rock powder with proven agronomic efficiency as soil remineralizer and alternative potash fertilizer.

Since 2011 TERRATIVA MINERAIS screened locations close to agricultural regions from the Cerrado and with favourable geology & logistics, for syenite rock with up to 14.5% potash content and also high content of other macronutrients. This rocks are uncommon, but Terrativa was able to locate them in key areas by using modern geological tools. TERRATIVA is developing five high grade potash mines (with up to 14.5% K₂O) and is planning the installation of four rock powder plants close to important agricultural zones from the Cerrado.

Actually Embrapa is running laboratory and agronomic efficiency tests to certify TERRATIVA rock powder products. Tests will be finished in Q1-2015; A 2 year research program from TERRATIVA with the MIT/USA developed Hydrosyenite (Ciceri et al. 2014), a second generation low cost high efficiency potash fertilizer produced from syenite and without by products, with controlled accelerated release of potash and also other benefits for agriculture.

TERRATIVA has several ultrapotassic igneous rocks projects in different regions of Brazil. This paper presents the Serra das Araras, Santa Bárbara and Baluarte projects, all located in the Brazilian Cerrado.

Location

The Serra das Araras project is located near the town of Goiás, approximately 150 km to the northwest of Goiânia, the capital of Goiás state, Brazil (Figure 1). The Santa Bárbara project is located near the town of Jaraguá, approximately 110 km to the north of Goiânia (Figure 1). The Baluarte project is located in the north part of the Mato Grosso state, approximately 750 km to the north of Cuiabá, the capital of state Fig. 1).

Geological setting

The ultrapotassic syenites of the Serra das Araras project were probably formed during the Brasiliano orogenic cycle and intruded the archaic orthogneisses of the Uvã Complex and mafic-ultramafic rocks of the Córrego Manoel Leocádio Formation. The project consists of at least three syenitic intrusions, especially NW intrusion, as shown in the map below (Figure 2) performed by TERRATIVA.

In the Santa Bárbara project, the syenitic intrusions are part of the neoproterozoic Itapuranga suite that intruded metagranitoids of the paleoproterozoic Jurubatuba suite and schists of the neoproterozoic Araxá group (Figure 3a). The rhyolites of the Baluarte project belong to the paleoproterozoic Colíder group and have similar ages compared with the intrusive rocks of the Teles Pires suite (Figure 3b).

Chemical and mineralogical compositions

The alkali feldspar syenite of the Serra das Araras project, is predominantly composed by alkali feldspar (> 97% modal), microcline type, as

the main K-silicate agromineral, with subordinate quartz, clinopyroxene, biotite and opaque minerals (< 3% modal), and display inequigranular textures, with medium alkali feldspar crystals in fine matrix (Fig. 5). The rocks are in general deformed, and mafic minerals are rare to absent. All the samples has K_2O content greater than 13.2%, SiO_2 less than 64% and Na_2O less than 1%.

In the Santa Bárbara project occur dominantly biotite-clinopyroxene-alkali feldspar syenite, with rare to absent quartz, and display equigranular, anisotropic, medium to coarse even-grained textures. Alkali feldspar is the forms anhedral crystals. In comparison with syenites from the Serra das Araras project, the syenites of the Santa Bárbara project derived from less evolved magmas, reflecting their lower K_2O (< 10%) and SiO_2 (< 60%) contents, and higher CaO (> 3%) and MgO (> 3%) contents (Fig. 5).

The Baluarte project have important occurrences of granophyric microsyenites, composed essentially by alkali feldspar (55% modal) and quartz (45% modal), with granophyric texture. These rocks have K_2O contents less than 10%, and high SiO_2 contents (> 75%).

Mineral potential estimates

The mineral potential estimate are supported so far only on geological criteria from extensive fieldwork executed by TERRATIVA in the Serra das Araras, Santa Bárbara and Baluarte projects. In the Serra das Araras project, the cited NW intrusion has mineral potential of approximately 40 Mt using a cut-off grade of 13.50% of K_2O . Santa Barbara project with its three main intrusions, has potential of about 200 Mt using a cut-off grade of 8% of K_2O smaller than that of the Serra das Araras project but with expressive CaO and MgO contents. In the Mato Grosso state, Baluarte project has mineral potential of approximately 70 Mt using a cut off grade of 9.5% of K_2O .

The Serra das Araras syenites can be used directly as K-fertilizer or from blends with mafic-ultramafic rocks with more expressive CaO and MgO contents and low-crystallinity mineralogy, which would improve the residual effect. The main potential of the Santa Barbara mafic syenites is being used directly as a soil conditioner or as K-fertilizer

from blends with ultrapotassic syenites of the Serra das Araras project. The Baluarte syenites should be used for the production of low cost high efficiency potash fertilizer, through the research program developed by TERRATIVA in partnership with MIT/USA.

Preliminary agronomic tests

Agronomic tests with the K silicate agromineral ($100\% < 0.15$ mm) for corn crop has been done. In a pot experiment was applied the recommended dose to corn crop based in total K rock content (100 mg of K per kg of soil, equivalent to 240 kg ha^{-1} of K_2O). The shoot dry mass in the treatment with the K silicate agromineral from the Baluarte Projects were not different from the control treatment. Better results were observed in plants treated with K silicate agromineral from Serra das Araras Project, those were 33.3% higher than the control treatment. And the shoot development were similar the treatment with the same dose of a known biotite schist (Oliveira, 2014b).

Those results showed a contradiction with the laboratory experiment. Extractants representing the soluble fraction were used and showed low extraction of K ($0.15, 0.36 \text{ g kg}^{-1}$ for citric acid and $0.21, 0.4 \text{ g kg}^{-1}$ for Mehlich-1, respectively Serra das Araras and Baluarte project).

Conclusions

The ultrapotassic rocks of Serra das Araras, Santa Bárbara and Baluarte projects occur in large volumes and show mineral potential to be used directly or in blends, as K-fertilizer or soil conditioner. Such rocks have significant K_2O contents (up to 15%) and, in the case of Santa Bárbara mafic syenites, CaO and MgO contents also.

The Serra das Araras ultrapotassic syenites has high potential for direct use as K-fertilizer or as Hydrosyenite, while Santa Bárbara mafic syenites may be used as soil conditioners. On the other hand, the Baluarte syenites should be used primarily as a source for production of Hydrosyenites. The implementation of one mine and ore concentration plant in the north-central part state of Mato Grosso (Baluarte project) and two mines and ore concentration plant in the southern state of Goiás, in a major consumer of fertilizers in Brazil markets, will

associate the quality of the product to a drastic reduction in logistics costs.

Keywords: K-silicate agrominerals, alternative potash fertilizar, Soil Conditioner, ultrapotassic syenite

References

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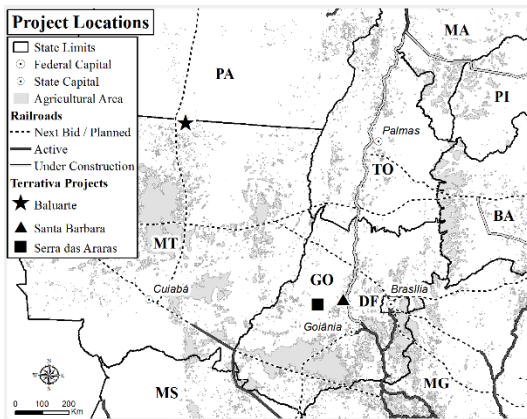


Figure 1. Location

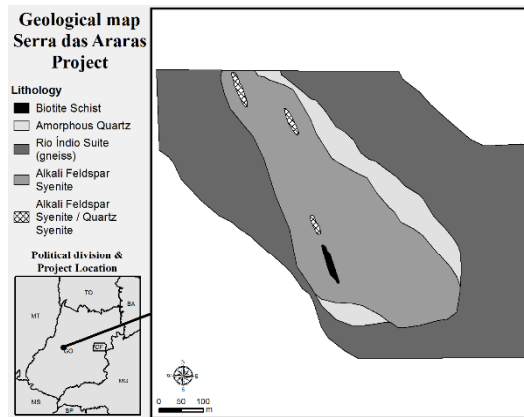


Figure 2. Geology of Serra das Araras Project

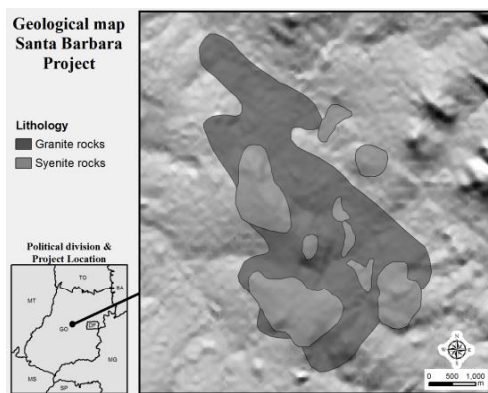


Figure 3a. Geology of Santa Bárbara Project

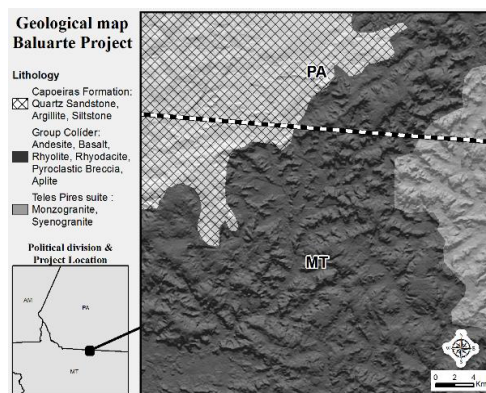


Figure 3b. Geology of Baluarte Project

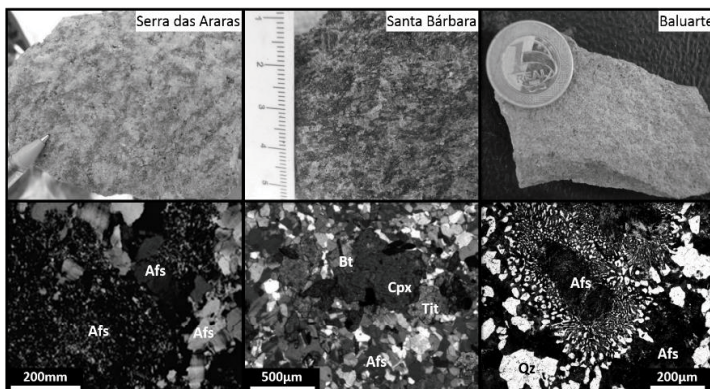


Figure 4. Minerals

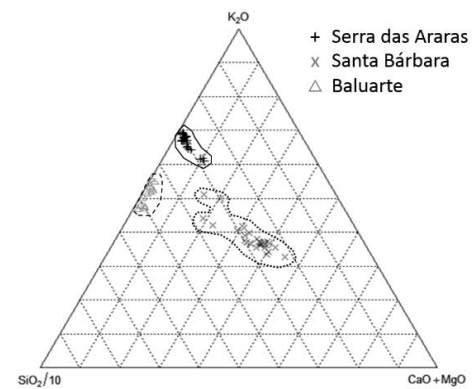


Figure 5. Chemical diagram