7

K-ALTERNATIVE FERTILIZER PROJECT: BIOTITE-BEARING ULTRAPOTASSIC DEPOSIT IN BAHIA STATE

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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. These 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% K_2O) 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, a second generation low cost high efficiency potash fertilizer produced from syenite by hydrotermal process, with controlled accelerated release of potash and also other benefits for agriculture.

In this scenario, TERRATIVA has several ultrapotassic igneous rocks projects in different regions of Brazil. In addition, the company is looking at areas with potential for soil conditioners such as the Ceraíma Project.

Location and geological setting

The Ceraíma Project is located in the municipality of Guanambi, approximately 675 kilometres west of Salvador, the capital of Bahia State, Brazil (Fig. 1).

The Ceraíma Project is geologically located in the domain of the Monzo-syenitic Guanambi-Urandi batholith, which consist of multiple intrusions of syenitic, monzonitic, granitic and monzo-dioritic rocks (Rosa, 1999).

The geological map of the Ceraíma Project performed by Terrativa is illustrates at Fig. 2. The units AFS-GNF, AFS-MAG and AFS are constituted by alkali feldspar syenite, and composed by the same main minerals, alkali feldspar, biotite and clinopyroxene. They differ by the proportion of these minerals and by the texture. The ALU unit is alluvion.

Mineralogy and chemistry

According to X-ray diffraction and petrographic analysis the AFS-GNF unit is composed by alkali feldspar (microcline – 77.0%), biotite (11%) and clinopyroxene (11%). Amphibole, titanite, magnetite and apatite occur as accessory minerals (<1% each one). The rock texture is phaneritic, inequigranular. The alkali feldspar crystals are anhedral to subhedral, fine to coarse, with film and diffuse pertites types. The main characteristic of this unit is the intergrowth between microscopic alkali feldspar crystals as "fingerprint", which suggests a rapid cooling condition of the magma (Fig.3).

The AFS-MAG unit is composed by alkali feldspar (microcline – 67%), plagioclase (12%), biotite (9%), clinopyroxene (6%), amphibole (3%) and

quartz (2%). Magnetite, titanite and apatite occur as accessory minerals (<1% each one). The rock texture is phaneritic, inequigranular, medium to coarse, with subhedral alkali feldspar crystals.

All the units mapped has very high K_2O content (predominantly greater than 11%) and high ratio K_2O/Na_2O (greater than 6), allowing classifies them as ultrapotassic. The chemical difference between the units is related the content of Al_2O_3 and Na_2O. The AFS-GNF unit has Al_2O_3 content greater than 17% and Na_2O less than 0.7%. The highest Al concentration in AFS-GNF is related to increased presence of biotite in this unit compared to the others. The lowest Na concentration is related with the absence of plagioclase in AFS-GNF.

Mineral potential estimates

The mineral potential estimates is been developing based on the data of 9 core boreholes (1,506 metres) executed by TERRATIVA in Ceraíma project (Fig. 2). The model is been blocked to a regular 50 m x 50 m x 10 m block model to account for dilution prior to pit optimization.

Considering the preliminary data of the potential estimative, all the drilling zone in the AFS-GNF and AFS-MAG units has mineral potential of 67,8 Mt using a cut-off grade of 12.50% of K_2O.

Preliminary agronomic tests

Agronomic tests with the K silicate agromineral (100% < 0.15 mm) for corn crop has been done by Embrapa (Gabos *et al.*, 2014 and Oliveira *et al.*, 2014) . 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 t ha^{-1} of K_2O). The plant dry mass in the treatment with the K silicate agromineral from the Ceraíma Project presented an increment 41.5% higher than the control treatment. The plant development were even higher 13.3 % than the treatment with the same dose of a known biotite schist. Those results are supported by the laboratory experiment. Extractants representing the soluble fraction were used and showed high extraction of K (2.4 g kg^{-1} for citric acid and 1.5 g kg^{-1} for Mehlich-1).

Conclusions

Ceraíma Potash Project has mineral potential of 67,8 Mt of syenite using a cut-off grade of 12.50% of K_2O. The great results of the AFS-GNF unit in the agronomic tests is attributed mainly to the high potash content, the feldspar texture and the considerable amount of biotite.

Keywords: Alternative K-fertilizer, Ultrapotassic syenite, Soil Conditioner

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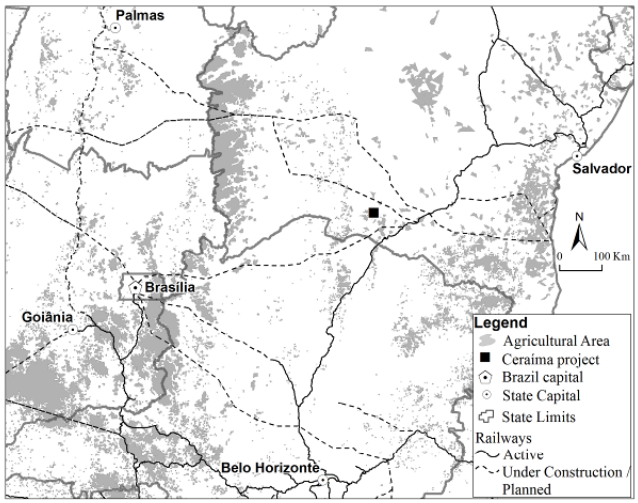

Figure 1. Location of Ceraíma syenite target

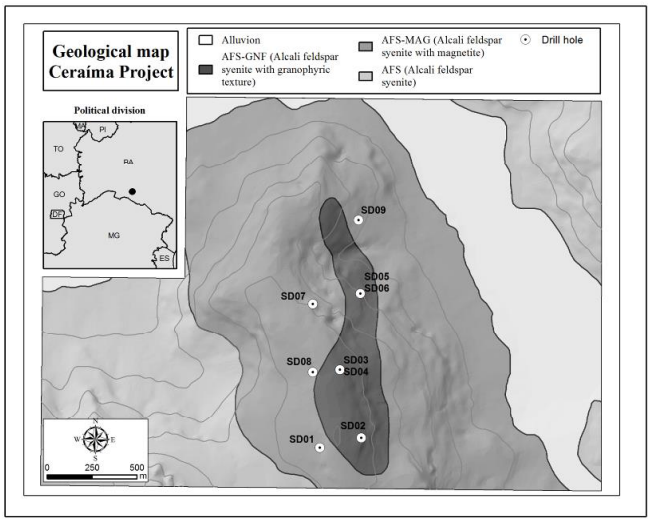

Figure 2. Geological map of Ceraíma Project.

Figure 3. Pictures of the biotite alkali-feldspar syenite from Ceraíma Project. (A) Outcrop, (B) Detail in a sample of borehole, (C) Photomicrography (X nicols) showing the intergrowth of alkali feldspar crystals