9

K, Ca AND Mg-BEARING AGROMINERALS FROM ULTRAMAFIC ROCKS: SOIL CONDITIONERS AND K-FERTILIZERS SOURCE

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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. 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% 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 (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.

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 Acreúna project.

Location and geological setting

The Acreúna project is located near the town of Santo Antônio da Barra, approximately 200 km to the southwest of Goiânia, the capital of Goiás state, Brazil (Figure 1). Acreúna project comprises alkaline mafic-ultramafic volcanic rocks emplaced as lava flows that alternate with pyroclastics deposits and associated late dykes and plugs. These rocks intruded the Precambrian basement and Phanerozoic sediments as part of the Late Cretaceous Goiás alkaline province.

Chemical and mineralogical compositions

The alkaline mafic-ultramafic rocks of the Acreúna project has kamafugitic affinity and can be divided into three varieties according to their chemical and mineralogical characteristics: tephriphonolite, ugandite and mafurite.

Tephriphonolites occur as four N-S elongate bodies of approximately 300 x 200 m (Figure 2), formed by 100% low cristallinity mineral phases, including sanidine (Figure 3), augita, olivine, and hematite, in an matrix that contains fine crystals. These rocks are richer in SiO_2 (45 to 54%) and K_2O (6 to 11%), compared to ugandites and mafurites (Figure 4).

Ugandites also form N-S elongate bodies, with similar sizes to those of tephriphonolites. The freshment specimens have a grey color and texturally they consist of an fine-grained matrix with phenocrysts of clinopyroxene (Figure 3), sanidine, magnetite, and vesicles filled mostly by K-zeolites (phillipsite, 14% modal) and subordinate carbonates. Their vesicularity varies from almost 5% to approximately 40%. The matrix and phenocrysts are composed of the same low crystallinity mineralogy. Chemically, ugandites are ultramafic rocks as mafurites, and have lower CaO and MgO those. K_2O contents are higher than the mafurites and lower than the tephriphonolites (Figure 4).

Mafurites are the most voluminous rocks of Acreúna project, occurring mainly in the northern and western portions. Texturally, they consist of an fine matrix with phenocrysts, both composed essentially por low crystallinity (Fig. 3) clinopyroxene (up to 85% modal), and subordinate magnetite, Na-zeolite (analcime) and calcite. As in ugandites, mafurites have vesicles filled with zeolites (analcime in this case) and carbonates. Mafurites have the lowest K_2O contents and higher CaO and MgO contents among rocks of Acreúna project.

In general, the rocks of Acreúna project are characterized by low-crystallinity mineral phases that compose them, as well as the expressive K_2O, CaO and MgO contents (Fig. 4).

Mineral potential estimates

Despite high K_2O contents of tephriphonolites, that would be an alternative to K-fertilizers, the main intention is to use the rocks of Acreúna project as blend components due to its expressive K_2O, CaO and MgO contents, low silica contents, the low-crystallinity of their mineral assemblages, as well as presence of characteristic zeolite, which has been used in agriculture as an important catalyst efficiency of fertilizer or as soil conditioner and decontaminant. The rocks of Acreúna project or the product of their blends in suitable proportions can be used directly as a soil conditioner. On the other hand, the blend between rocks of Acreúna and syenites allow the creation of K-fertilizer more efficiently and better residual effect.

The mineral potential estimates is supported so far only on geological criteria from extensive fieldwork executed by TERRATIVA in Acreúna project. Thus, tephriphonolites and ugandites has mineral potential of approximately 30 Mt each one, while mafurites has potential of about 50 Mt. Considering the average fertilizer and soil conditioner production of 1.5 Mt/year in the Acreúna design plant, the mineral potential would be able to feed for at least 30 years.

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 plants dry mass in the treatment with the K-silicate agrominerals from the Acreúna Project were higher than the control treatment, the increments were 27.5, 41.5 and 21.1% for Ugandite, Mafurite and Tephriphonolite, respectively. The shoot development were similar to the treatment with the same dose of a known biotite schist (Oliveira, 2014b).

Those results are supported by the laboratory experiment. Extractants representing the soluble fraction were used and showed high extraction of K (2.0, 2.0 and 0.8 g kg^{-1} in citric acid; and 0.5, 0.6 and 0.8 g kg^{-1} in Mehlich-1, for both extractants respectively, Ugandite, Mafurite and Tephriphonolite).

Conclusions

The rocks of Acreúna project occur in large volumes and show mineral potential to be used directly or in blends with each other or syenites, as soil conditioner or K-fertilizer. Such rocks have significant K_2O, CaO and MgO contents, important macronutrients, and low-crystallinity mineralogical assemblages which facilitates the release of macro- and micronutrients and causes a good residual effect for plants.

The chemical and mineralogical characteristics of the rocks of Acreúna, as well as the possible products from different idealized blends, makes them a very interesting alternative to the K-fertilizer and soil conditioner market. Moreover, the implementation of 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-fertilizer, Soil Conditioner, Low-crystalinnity minerals, zeolites, residual effect

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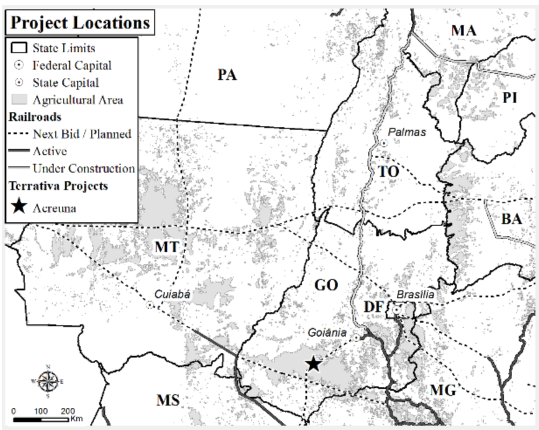

Figure 1. Location

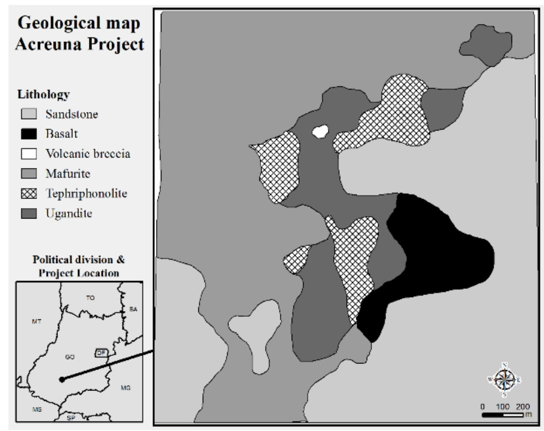

Figure 2. Geology

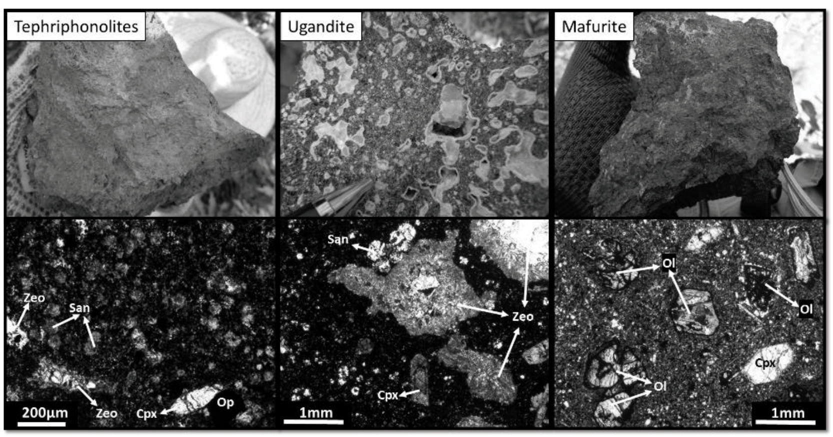

Figure 3. Hand samples and microtextures.

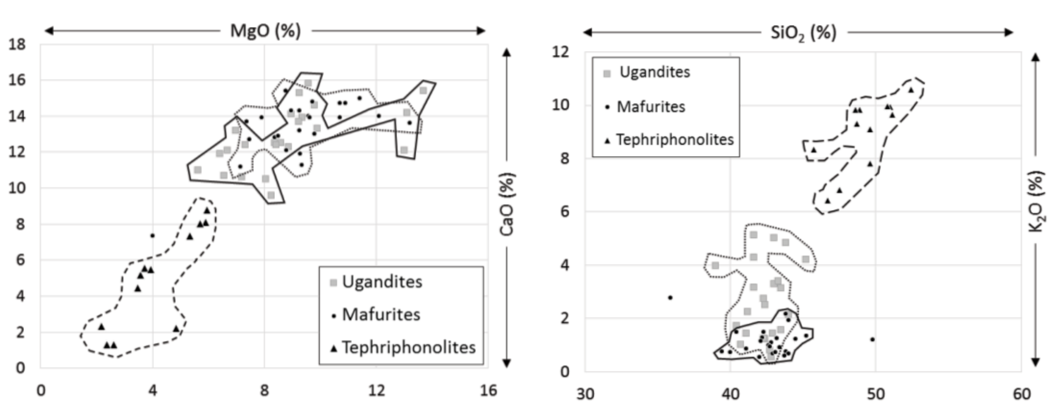

Figure 4. Content of K_2O, MgO and CaO