

# Rb-Sr AND K-Ar AGES FOR PEGMATITES FROM THE BANABUIÚ REGION, BORBOREMA PROVINCE, BRAZIL.

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## INTRODUCTION

This work reports Rb-Sr and muscovite K-Ar ages for different pegmatite bodies of the Banabuiú region (NE Brasil). The results are discussed and compared in an attempt to constrain the emplacement of these rocks.

## GEOLOGICAL SETTING

The Banabuiú region is located in the Central Ceará Domain (CCD) of the Borborema Province, in northeastern Brasil. During the Brazilian/Pan-African orogeny (Neoproterozoic), involving the continental collision of the São Luis-Western African and São Francisco/Congo-Kasai cratons (Van Schmus *et al*, 1997), this area was strongly affected by deformation, high-grade regional metamorphism and magmatism. As a result, the basement rocks of Paleoproterozoic age were extensively transformed into gneisses and migmatites and intruded by S-type, syn-to late-kinematic two-mica granites. At a later stage, both the basement and the granite were penetrated by several bodies of pegmatites.

According to the classification scheme proposed by Sousa (1985), the Banabuiú pegmatites can be included in the Solonópole-Quixeramobim Pegmatic District (SQPD) of the Ceará Pegmatic Province (Fig. 1). This district hosts the largest and the most economically interesting deposits, which have been subdivided into five fields based on the type of mineralization (Souza, 1985; Marques Jr., 1992; Vidal & Nogueira Neto, 2005): (1) Nova Floresta-Feiticeiro field with cassiterite and tantalite-columbite rich pegmatites; (2) NE Solonópole field, hosting lithium-beryl-tantalite and lithium-beryl-tin rich pegmatites; (3) W and NW Solonópole field with lithium-beryl-tin pegmatites; (4) Berilândia-Carnaubinha field, known by their gem-bearing pegmatites - aquamarine and gemological tourmalines; (5) Rinaré-Banabuiú field, with beryl and gemological tourmalines.

## THE BANABUIÚ PEGMATITES

The Banabuiú pegmatites are predominantly hosted by the CCD gneiss-migmatite complex, occurring more rarely within the granite intrusion. Most of the

pegmatites associated with the granite are barren, homogeneous and tend to occur as fracture-filling dykes and veins, less than 1 m thick. In contrast, the basement gneisses contain both homogeneous and heterogeneously zoned pegmatites showing conformable to cross-cutting relationships and highly variable shapes and sizes. Some of these appear to represent segregations of anatetic leucosomes, whilst others form clearly discordant bodies and may reach hundreds of metres in length and a few tens of metres across.

The latter group commonly exhibits complex internal structures and displays a zoned pattern, consisting of the following units, from the margins inward: (1) a thin aplitic border zone, not always present, (2) a wall zone, composed of quartz

+ K-feldspar + plagioclase (albite) + muscovite; (3) an intermediate zone, with blocky quartz and K-feldspar (4) a core zone of coarse grained quartz. The accessory ore minerals (apatite, amblygonite, beryl, columbite-tantalite, cassiterite, tourmaline, spodumene) are generally concentrated in the wall and intermediate zones (Vidal & Nogueira Neto, 2005). Structural studies in the Banabuiú-Solonopole Pegmatic field show that the strike of the large pegmatite bodies tends to vary between N5°E – N15°E, suggesting that their emplacement may have been controlled by the major shear zones that cross-cut the area - the Senador Pompeu and the Orós shear zones (Marques Jr *et al.*, 1988; Marques Jr, 1992; Marques Jr & Nogueira Neto, 1992).

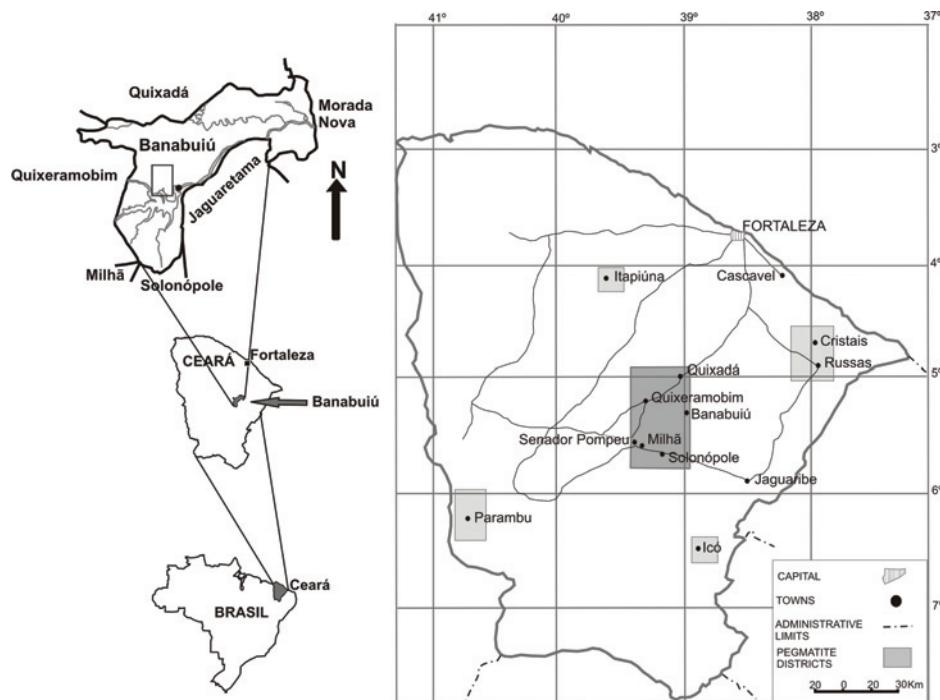


Figure 1 – Main Pegmatitic Districts in the Ceará State (Souza, 1985).

All the Banabuiú pegmatites have quartz, albite, K-feldspar and muscovite as their main rock-forming minerals. Tourmaline and garnet are common in both homogeneous and heterogeneous types, although the gemstocks and ore minerals are found only in the zoned pegmatites. Their mineral assemblages, particularly the widespread occurrence of peraluminous silicates, such as muscovite, garnet and tourmaline, are typical of pegmatites with A/CNK ratios  $> 1$  and point to their inclusion in the LCT (lithium – cesium – tantalum) family (Cerny, 1991). As shown by several authors, efficient fractionation of crustal derived felsic magmas can lead to LCT-type pegmatites, in which the peraluminous character amplifies the signature of the metasedimentary source rocks. It is therefore likely that these pegmatites are genetically related to the syn- to late-orogenic S-type granite

exposed in the western sector of the study area.

### Rb-Sr AGES

In granitic pegmatites, the Rb-Sr radiogenic isotope systems are frequently affected by  $^{87}\text{Sr}$  loss due to post-consolidation mobility of radiogenic Sr. As a result, unrealistically low ages and abnormally high  $^{87}\text{Sr}/^{86}\text{Sr}$  initial ratios may be produced. However, the Rb-Sr isochrons obtained on cogenetic minerals often show good agreement with the K-Ar, Ar-Ar and U-Pb ages and have been widely used for geochronological purposes. As such, one of the zoned pegmatite bodies cropping out in the basement of the Banabuiú region was selected for Rb-Sr dating. The isotopic analyses obtained in mineral separates (albite, K-feldspar and muscovite) of this pegmatite are listed in Table 1.

Table 1 – Sr isotope data for minerals of a zoned pegmatite from the Banabuiú region\*

Samples	Minerals	ppm Sr	ppm Rb	$^{87}\text{Rb}/^{86}\text{Sr}$	Error (2s)	$^{87}\text{Sr}/^{86}\text{Sr}$	Error (2s)
MI 187	Albite	5,55	85,67	46,61	0,44	1,156197	0,000066
MI 187	K-Feldspar	12,92	2700,28	1036,80	18,36	8,017049	0,000438
MI 187	Muscovite	5,58	2782,02	23733,62	415,05	158,621488	0,029495

\* obtained in the Laboratory of Isotope Geology of the University of Aveiro, Portugal

The data points define a linear array yielding an age of  $506.0 \pm 6.1$  Ma, with  $^{87}\text{Sr}/^{86}\text{Sr}_i = 0.8444$  and MSWD = 0.14 (Isoplot-model 1, Ludwig, 2003). The age obtained falls within the range proposed by Almeida *et al.* (1968) for the pegmatites of the Solonópole-Quixeramobim District (470 – 530 Ma) and is consistent with the geological constraints. Nevertheless, considerable care must be taken in

interpreting this age as the time of pegmatite formation, since the degree of post-crystallization migration of Sr and Rb isotopes is not known.

### MUSCOVITE K-Ar AGES

Large muscovite crystals from three pegmatite bodies from the Banabuiú region were separated for K-Ar dating (MI 88, MI

96 and MI 187). Samples MI 88 and MI 96 are from two homogeneous pegmatite dykes intruding the granite and the CCD gneisses, respectively, whereas sample MI 187 is from the heterogeneously zoned pegmatite mentioned above. The K-Ar ages are presented in Table 2. As the closure temperature for Ar diffusion

in muscovite is  $350 \pm 50$  °C, the obtained ages should be interpreted as cooling ages and provide only minimum estimates for the time of pegmatite crystallization. It is therefore possible that the magmatic age of these rocks is older than implied from the K-Ar data.

Table 2 – K-Ar data for muscovites from the Banabuiú pegmatites\*\*

Samples	Rock type	%K	Error	$^{40}\text{Ar rad}$	$^{40}\text{Ar atm}$	T (Ma)	Idade (Ma)	Error
MI 88	Homogeneous pegmatite	7,3671	1,0000	172,37	7,47	532,8	519,8	13,0
MI 96	Homogeneous pegmatite	8,1767	1,0000	193,57	7,09	537,2	525,1	12,0
MI 187	Zoned pegmatite	7,5153	1,1519	179,74	6,00	542,7	529,8	12,9

\*\*obtained in the Institute of Geosciences, University of São Paulo-USP, Brazil

The discordance between the K-Ar and Rb-Sr ages for sample 187 ( $506.0 \pm 6.1$  Ma vs.  $529.8 \pm 12.9$  Ma) may, on the other hand, result from open-system behaviour of the Rb-Sr system with a consequent lowering of the Rb-Sr age.

## CONCLUSIONS

Based on the Rb-Sr and K-Ar ages obtained for different pegmatite bodies from the Banabuiú region, it may be suggested that their emplacement took place at c.a. 530-500 Ma. However, as the K-Ar and the Rb-Sr isotope systems are both extremely sensitive to temperature, further isotope data using more reliable dating techniques (U-Pb, Ar-Ar) are required to determine the real crystallization age of these bodies.

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*Rb-Sr AND K-Ar AGES FOR PEGMATITES FROM THE BANABUIÚ REGION,  
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