

## NEW K-Ar AGES OF THE PRIMARY TIN MINERALIZATION IN THE RONDÔNIA TIN PROVINCE, BRAZIL<sup>a</sup>

Leite Júnior, W.B.<sup>1</sup>, Payolla, B.L.<sup>1,2</sup>, Bettencourt, J.S.<sup>3</sup>, Tassinari, C.C.G.<sup>3</sup>

<sup>1</sup> Instituto de Geociências e Ciências Exatas, UNESP, Rio Claro, SP, Brazil. E-mail: wleite@rc.unesp.br

<sup>2</sup> Centrais Elétricas do Norte do Brasil, Brasília, DF, Brazil. E-mail: bruno@eln.gov.br

<sup>3</sup> Instituto de Geociências, USP, São Paulo, SP, Brazil. E-mail: jsbetten@usp.br, ccgtassi@usp.br

<sup>a</sup> Financial support: PADCTII/Finep (65.94.0249.00) and PADCTIII/Finep (64.99.027.00)

**Keywords:** Geochronology, tin mineralization, Rondônia, Brazil

### INTRODUCTION

At present, the main primary tin mineralizations in the Rondônia tin province are thought to be related to the three youngest rapakivi suites identified in this province. These rapakivi suites are: the São Lourenço-Caripunas Intrusive Suite (ca. 1.31 Ga), the Santa Clara Intrusive Suite (1.08-1.07 Ga) and the Younger Granites of Rondônia (1.00-0.97 Ga) (Bettencourt et al., 1999). Priem et al. (1971) report a K-Ar age of  $995 \pm 40$  Ma on biotites of greisen from the Oriente Novo massif (now includes in the Santa Clara Intrusive Suite) and conclude that tin mineralizations took place at the same time of the granitic intrusions, about  $980 \pm 20$  Ma ago (Rb-Sr age). This study reports additional K-Ar ages on separated Li-Fe micas (protolithionites and zinnwaldites) of greisens and quartz veins spatially associated with the granites of the Santa Clara and Younger Granites of Rondônia suites.

### THE SANTA CLARA INTRUSIVE SUITE AND THE YOUNGER GRANITES OF RONDÔNIA

The Santa Clara Intrusive Suite and the Younger Granites of Rondônia occur side by side at the central-eastern part of the Rondônia tin province (Fig. 1). Both suites have petrographic, geochemical and metallogenetic similarities. The suites are composed of several early- and late-stage intrusions. The early-stage intrusions are dominant in area, exhibit a metaluminous to slightly peraluminous character, and are formed mainly by biotite ( $\pm$ hornblende) monzogranite and syenogranite and/or biotite monzogranite and syenogranite, showing rapakivi textures. The late-stage intrusions are volumetrically smaller and comprise two

compositional rock groups: (1) a metaluminous to peralkaline group composed mainly of hornblende ( $\pm$ pyroxene) alkali-feldspar syenite, microsyenite, trachyandesite and trachyte, as well as biotite ( $\pm$ sodic amphibole) alkali-feldspar microgranite and rhyolite; (2) a peraluminous group formed by biotite alkali-feldspar granite, Li-mica ( $\pm$ topaz) alkali-feldspar granite and rhyolite (ongonite). The Sn-polymetallic deposits are closely associated with these late-stage peraluminous rocks in both suites mostly as: disseminated mineralization with cassiterite and columbite-tantalite in the Li-mica ( $\pm$ topaz) alkali-feldspar granite, endo- and exogreisen bodies with cassiterite, quartz veins with cassiterite and wolframite, and veins and veinlets with Zn-Cu-Pb-Fe sulphides (Leite Júnior et al., 2000, 2001).

### SAMPLE MATERIAL, ANALYTICAL PROCEDURES AND K-Ar ISOTOPIC RESULTS

Four samples of greisen from inactive Oriente Novo mine (samples 23A and 8B), inactive Rio Branco mine (sample 118811B) and Santa Bárbara mine (sample SB-3), and two samples of quartz vein from inactive Oriente Novo mine (sample ON-1) and Bom Futuro mine (BF-12) were selected for separation of the micas (Fig. 1). After crushing and sieving the rocks, the micas were separated shaking the 60-80 mesh fractions on a tilted paper sheet and then using a Frantz isodynamic separator. The mica separates were further purified by hand picking under a binocular microscope. The K-Ar age determinations were conducted at the Geochronological Research Center of University of São Paulo using techniques described by Amaral et al. (1966) with some modifications. The K analyses were

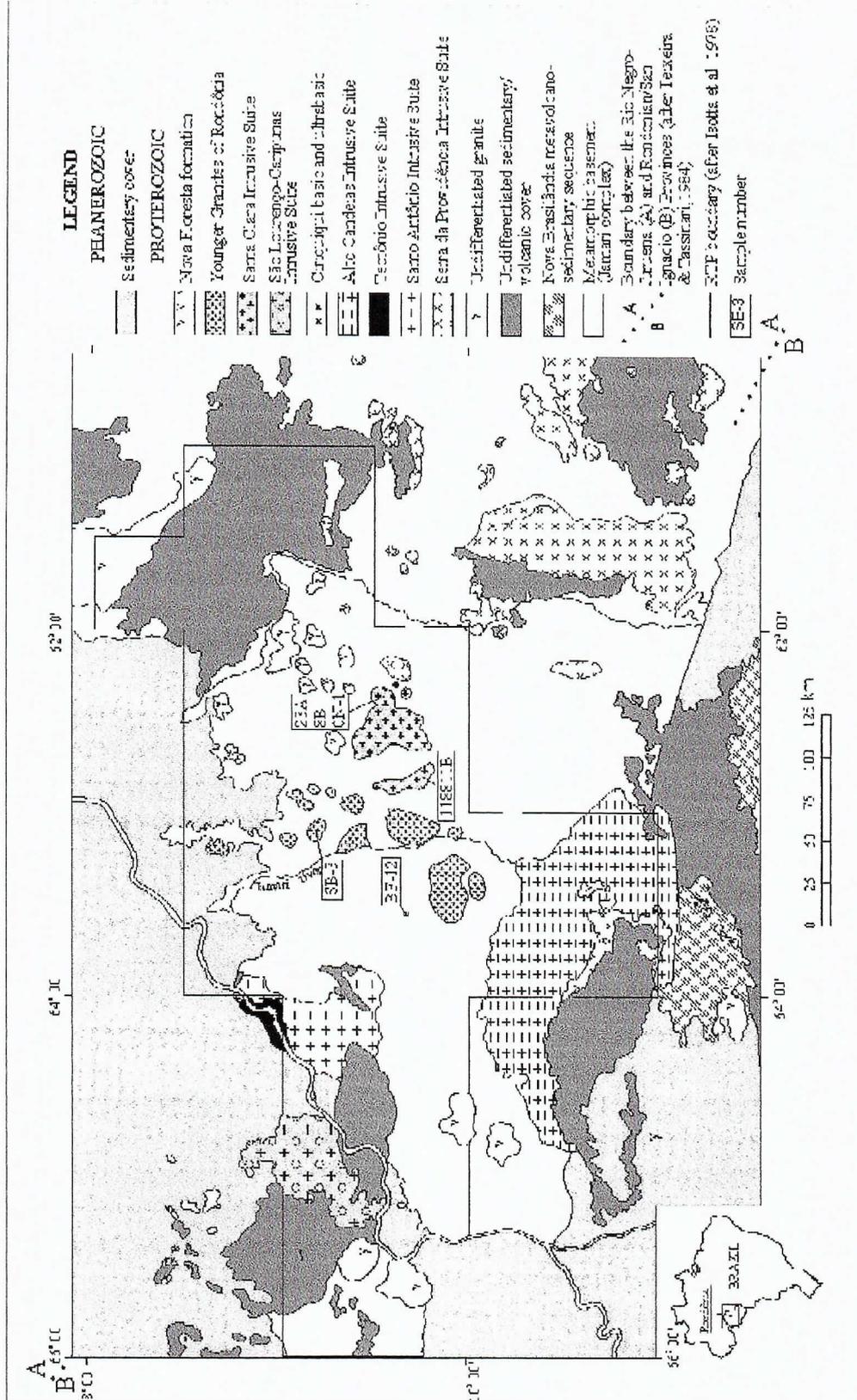


Figure 1 - Geological map of the Rondônia Tin Province (RTP) and adjacent areas (modified after Beltercourt et al., 1999)

made by flame photometry with a Micronal B-262 machine, using a lithium internal standard. The Ar extraction was made in a high vacuum system with pressure usually less than  $10^{-8}$  mm/Hg. Isotopic analyses of the purified argon was made in MS-1 Nuclide mass spectrometer completely modified. All ages have been calculated with the decay constants

recommended by Steiger and Jäger (1978) and are given with standard error ( $1\sigma$ ) estimates. The constants used in the calculations are:  $\lambda_e^{40}\text{K} = 0.581 \times 10^{-10} \text{ yr}^{-1}$ ,  $\lambda_\beta^{40}\text{K} = 4.962 \times 10^{-10} \text{ yr}^{-1}$ , atomic  $^{40}\text{Ar}/^{36}\text{Ar}$  ratio = 295.5 and abundance  $^{40}\text{K} = 0.0116$  atom percent total K. Analytical data are presented in Table 1.

**Table 1-** Results of K-Ar isotopic analyses on Li-Fe micas of greisens and quartz veins from the Santa Clara Intrusive Suite and the Younger Granites of Rondônia.

Rock	Sample	K (%)	Error K (%)	Rad. $^{40}\text{Ar}$ ccSTP/g ( $10^{-6}$ )	Atmos. $^{40}\text{Ar}$ (%)	Age (Ma)
<b>Santa Clara Intrusive Suite (1080-1070 Ma, U-Pb zircon age)</b>						
Greisen <sup>1</sup>	23A	8.0372	0.6125	420.38	1.90	<b>1006±17</b>
Greisen <sup>2</sup>	118811B	8.0800	2.4194	405.91	1.30	<b>976±30</b>
Greisen <sup>1</sup>	8B	8.2904	3.0000	419.19	2.61	<b>981±35</b>
Quartz vein <sup>1</sup>	ON-1	7.6314	0.5000	392.79	1.54	<b>993±16</b>
<b>Younger Granites of Rondônia (1000-970 Ma, U-Pb zircon age)</b>						
Greisen <sup>3</sup>	SB-3	8.0207	0.9744	395.64	1.65	<b>961±19</b>
Quartz vein <sup>4</sup>	BF-12	8.3438	2.0047	415.77	2.02	<b>969±27</b>

Sample location: <sup>1</sup> Inactive Oriente Novo mine, <sup>2</sup> Inactive Rio Branco mine, <sup>3</sup> Santa Barbara mine, and <sup>4</sup> Bom Futuro mine.

## DISCUSSION AND CONCLUSIONS

K-Ar analyses performed on four mica samples of greisen and quartz vein from the Santa Clara Intrusive Suite yield ages between 1006 Ma and 976 Ma. These ages include, within analytical uncertainties, the age reported by Priem et al. (1971) and are at least 70 Ma younger than the ca. 1074 Ma crystallization age of the late-stage peraluminous granites and rhyolite (Leite Júnior, in preparation). On the other hand, the ages of 961 Ma and 969 Ma on mica samples of greisen and quartz vein from the Younger Granites of Rondônia are slightly lower than the ca. 974 Ma

crystallization age of the late-stage peraluminous granites of this suite. From these data we conclude that the K-Ar age of ca. 965 Ma may represent the age of the hydrothermal tin mineralization related to the Younger Granites of Rondônia and suggests that this mineralization took place soon after the crystallization of the late-stage peraluminous granites and rhyolites. The K-Ar ages between 1006 Ma and 976 Ma obtained on micas of greisens and quartz vein from the Santa Clara Intrusive Suite probably indicate an Ar loss due to thermal effect caused by the emplacement of the neighbouring Younger Granites of Rondônia. An Ar loss around this time is also

observed on biotites of granites from the Santa Clara Intrusive Suite (Oriente Novo massif) and of augen gneiss from the basement complex (see Priem et al., 1971; Bettencourt et al., 1996). Thus, the precise age of the hydrothermal tin mineralization related to the Santa Clara Intrusive Suite remains an open question, although the field evidence and the presence of dominant magmatic water, indicated by preliminary fluid inclusion studies, and D/H and  $^{18}\text{O}/^{16}\text{O}$  compositions on micas suggest an age slightly younger than the age of the late-stage peraluminous granites and rhyolites (ca. 1074 Ma).

## REFERENCES

- Amaral, G., Cordani, U.G., Kawashita, K., and Reynolds, J.H. 1966. Potassium-Argon dates of basaltic rocks from southern Brazil. *Geochemica et Cosmochimica Acta*, **30**:150-189.
- Bettencourt, J.S., Onstott, T.C., De Jesus, T. and Teixeira, W. 1996. Tectonic interpretation of  $^{40}\text{Ar}/^{39}\text{Ar}$  ages on country rocks from the central sector of the Rio Negro-Juruena Province, southwest Amazonian craton. *Intern. Geol. Rev.*, **38**:42-56.
- Bettencourt, J.S., Tosdal, R.M., Leite Júnior, W.B. and Payolla, B.L. 1999. Mesoproterozoic rapakivi granites of the Rondônia Tin Province, southwestern border of the Amazonian craton, Brazil – I. Reconnaissance U-Pb geochronology and regional implications. *Precambrian Research*, **95**:41-67.
- Faure, G. 1986. *Principles of isotope geology*. 2<sup>a</sup> ed. Singapore, John Wiley & Sons, 589 p.
- Leite Júnior, W.B. *A Suíte Intrusiva Santa Clara (RO) e a mineralização primária polimetálica (Sn, W, Nb, Ta, Zn, Cu, Pb) associada*. Instituto de Geociências, Universidade de São Paulo, São Paulo, Brazil, PhD. Thesis (in preparation).
- Leite Júnior, W.B., Bettencourt, J.S. and Payolla, B.L. 2001. 1.08-1.07 Ga A-type granite magmatism in the Rondônia tin province, SW Amazonian craton, Brazil: petrologic and geochemical constraints. In: GAC-MAC Annual Meeting, St. John, Canada (in press).
- Leite Júnior, W.B., Payolla, B.L. and Bettencourt, J.S. 2000. Petrogenesis of two Grenvillian tin-bearing rapakivi granite suites, southwestern Amazonian craton, Rondônia, Brasil. In: SBG/IUGS, Intern. Geol. Congr., 31<sup>st</sup>, Rio de Janeiro, Brazil, CD-ROM.
- Priem, H.N.A., Boelrijk, N.A.I.M., Hebeda, E.H., Verdurmen, E.A.Th., Verschure, R.H. and Bon, E.H. 1971. Granitic complexes and associated tin mineralization of 'Grenville' age in Rondônia, Western Brazil. *Geol. Soc. Amer. Bull.*, **82**:1095-1102.
- Steiger, R.H. and Jäger, E. 1978. Subcommission on geochronology: convention on the use of decay constants in geochronology and cosmochronology. Contributions to the geologic Time Scale. *Studies in Geology*, **6**:67-72.