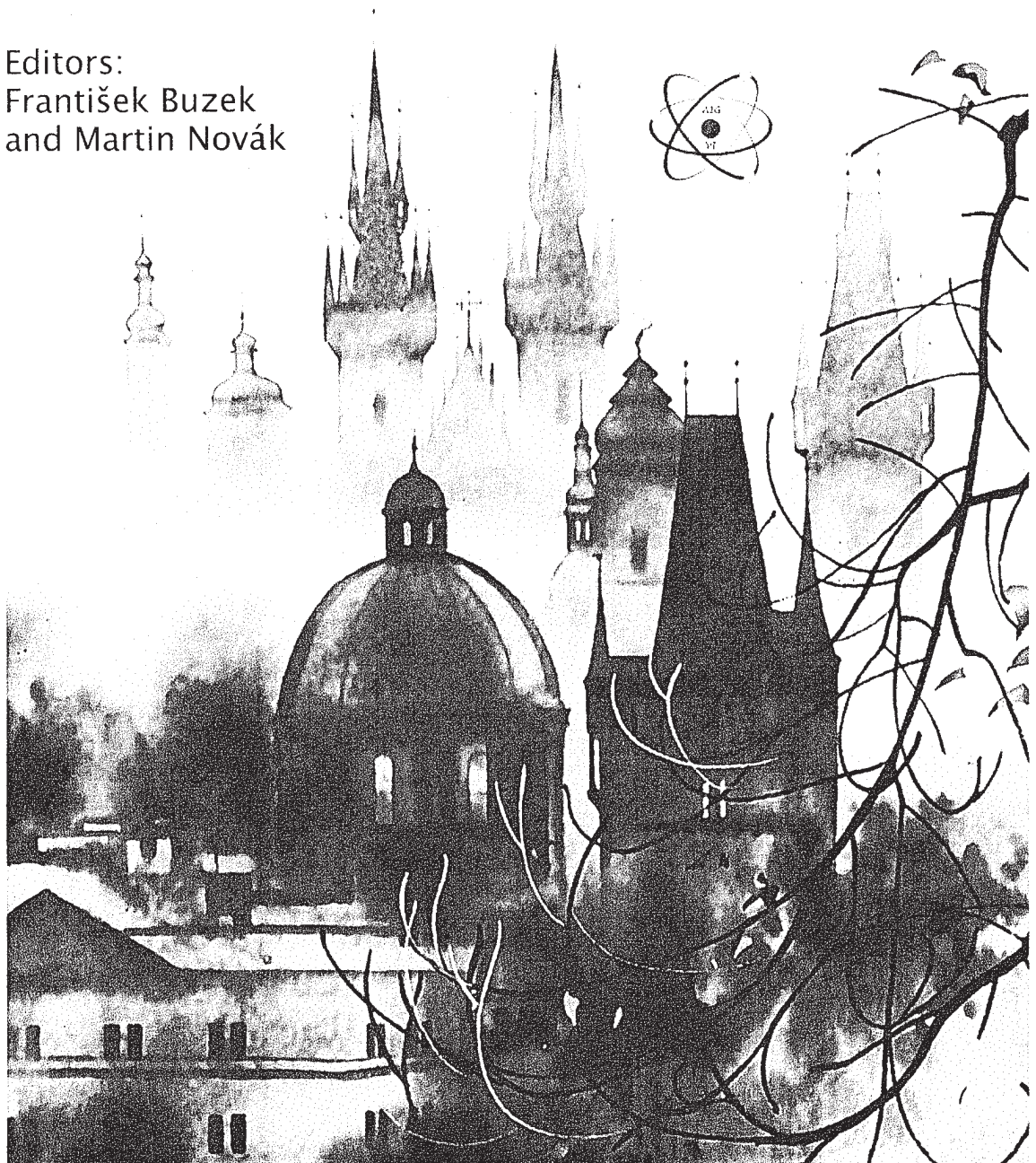
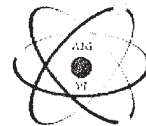


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# Geochemistry and isotopic data of the granitic rocks from Castelo Branco pluton (Central Portugal)

*I. M. H. R. ANTUNES<sup>1</sup>, A. M. R. NEIVA<sup>2</sup>, M. M. V. G. SILVA<sup>2</sup>*

<sup>1</sup> Polytechnic Institute of Castelo Branco, Quinta da Senhora de Mércules, 6001-909 Castelo Branco, Portugal; e-mail: imantunes@esa.ipcb.pt

<sup>2</sup> Department of Earth Sciences, University of Coimbra, Largo Marquês de Pombal, 3000-272 Coimbra, Portugal

## Geology

The Castelo Branco pluton is exposed over an area of 390 km<sup>2</sup> and consists of five late- to post-tectonic Hercynian granitic rocks, which intruded the Cambrian schist-metagraywacke complex. They are concentrically arranged. A medium- to fine-grained muscovite>biotite granite (G1) crops out in the pluton's core and is surrounded by a medium- to fine-grained, slightly porphyritic biotite>muscovite granodiorite (G2), encircled by a medium- to coarse-grained porphyritic biotite>muscovite granodiorite (G3), grading into a medium- to coarse-grained porphyritic biotite = muscovite granite (G4). A coarse-grained muscovite>biotite granite (G5) forms only external parts of the pluton in the N and NE.

## Geochemistry of rocks and minerals

All granitic rocks are peraluminous with the molecular ratio  $A/CNK = Al_2O_3/(CaO+Na_2O+K_2O)$  of 1.10 - 1.19. The biotite>muscovite granodiorites G2 and G3, biotite = muscovite granite G4 and muscovite>biotite granite G5 show fractionation trends for oxides and trace elements. The muscovite>biotite granite G1, cropping out in the pluton's core, does not fit the general trend in the variation diagrams for MgO, Cr, Sr, Rb, Th, K/Rb, Sr/(K+Ca), Li/Mg, Ba/K, Rb/Sr and Rb/Ba. The REE patterns for granitic rocks G2, G3 and G4 are subparallel with a decrease in all rare earths and despering negative Eu anomaly from G2 to G4. The REE pattern of granite G5 cross cuts that of granite G4 in the HREE. The granite G1 is poorer in all REE than granitic rocks G2, G3 and G4. The rare earth pattern of granite G1 cuts that of granite G5 in the HREE.

Biotites of the granitic rocks ranging from biotite>muscovite granodiorite G2 to biotite = muscovite granite G4 define trends of fractionation for major and trace elements. The biotites from muscovite>biotite granites G1 and G5 plot outside the general trends in the diagrams for Al, Cr, Zn, Ba, Cs, Co, Ga, Ni/Fe<sup>2+</sup> and Rb/K.

The anorthite content of plagioclase is generally lower in matrix than in the phenocrysts. There is a decrease in anorthite content of phenocryst and matrix plagioclase from granodiorite G2 to granite G4. The plagioclase from the muscovite>biotite granite G5 has a similar to higher anorthite content than that of plagioclase from biotite = muscovite granite G4. The plagioclase composition of muscovite>biotite granites G1 and G5 is similar.

## Isotopic data

Zircon and monazite were separated from one sample of each granitic rock G1, G2 and G5. Zircon and monazite ages were obtained by conventional isotopic U-Pb analyses (ID-TIMS). The age of 310 Ma was obtained for zircon and monazite from all the samples.

The granodiorites G2 and G3 and granite G4 define a whole-rock Rb-Sr isochron, which yields an age of  $300 \pm 16$  Ma, (<sup>87</sup>Sr/<sup>86</sup>Sr)<sub>0</sub> ratio of  $0.7113 \pm 0.0033$  and MSWD = 0.210.

The average (<sup>87</sup>Sr/<sup>86</sup>Sr)<sub>310</sub> ratios for G1, G2 and G5 are  $0.7090 \pm 0.0011$ ,  $0.7105 \pm 0.0024$  and  $0.7120 \pm 0.0003$ , respectively.

Whole-rock oxygen isotope ( $\delta^{18}O$ ) values range from +12.3 to 13.5 ‰ (Table 1).  $\delta^{18}O$  increases from biotite>muscovite granodiorite G2 to muscovite>biotite granite G5 and is positively correlated with SiO<sub>2</sub>, Li, Rb and negatively correlated with total FeO, Sr and Ba. The muscovite>biotite granite G1 plots outside the general trend in each diagram.

## Petrogenesis

The granitic rocks from Castelo Branco pluton are of S-type (Chappell and White, 1992). The variation diagrams for major and trace elements and ratios of these rocks and of  $\delta^{18}O$  versus SiO<sub>2</sub>, Li, Rb, total FeO, Sr and Ba suggest a crystal fractionation model for granodiorites G2 and G3 and granites G4 and G5, while the granite G1 does not fit the general trend.

Table 1. Mean isotopic ratios for the granitic rocks from Castelo Branco, Central Portugal.

|   | G1     | G2     | G3     | G4     | G5     |
|---|--------|--------|--------|--------|--------|
| $\delta^{18}\text{O}$ (‰)               | 13.54  | 12.27  | 12.50  | 12.75  | 12.91  |
| $(^{87}\text{Sr}/^{86}\text{Sr})_{310}$ | 0.7090 | 0.7108 | 0.7104 | 0.7090 | 0.7120 |

G1 medium- to fine-grained muscovite>biotite granite; G2 medium- to fine-grained slightly porphyritic biotite>muscovite granodiorite; G3 medium- to coarse-grained porphyritic biotite>muscovite granodiorite; G4 medium- to coarse-grained porphyritic biotite = muscovite granite; G5 coarse-grained muscovite>biotite granite.

The decrease in LREE from granodiorite G2 to granite G4 can be explained by fractionation of monazite (Yurimoto et al. 1990), while the decrease in MREE and HREE can be attributed to apatite fractionation, but the decrease in HREE can also be due to zircon fractionation (e.g., Mittlefehldt and Miller 1983).

The chondrite-normalized rare earth pattern of granite G5 cuts that of granite G4 on HREE, suggesting that G5 does not belong to the sequence. The rare earth patterns of G1 and G5 cut each other on HREE, indicating that they are not related.

The biotites of granitic rocks G2, G3 and G4 show fractionation trends for major and trace elements, but biotites of G1 and G5 do not fit the general trend, confirming that these two granites do not belong to the sequence. Furthermore, plagioclase from G5 tends to have a slightly higher anorthite content than that of plagioclase from G4, confirming that G5 does not belong to the sequence.

The granitic rocks G2, G3 and G4 define a whole-rock Rb-Sr isochron, supporting the sequence and G5 does not fit it. The initial  $^{87}\text{Sr}/^{86}\text{Sr}$  calculated for all samples of granitic rocks G2, G3 and G4 for the age of 310, obtained by U-Pb for zircon and monazite from granodiorite G2, have an average value of  $0.7100 \pm 0.0016$ , which is similar to that given by the Rb-Sr isochron. Therefore, these granitic rocks are cogenetic and assimilation of country rock did not occur simultaneously with in situ fractional crystallization.

Least squares analysis of major and trace elements and modelling of trace elements indicate that G3 and G4 were derived from the granodiorite magma G2 by fractional crystallization of quartz, plagioclase and biotite.

G1, G2 and G5 have originated by partial melting of metasediments (Table 1). They correspond to three distinct pulses of granitic magma and are  $310 \pm 1$  Ma old.

## References

- Chappell B.W., White A.J.R. (1992): I- and S-type granites in the Lachlan Fold Belt. *Trans. Roy. Soc. Edin. Earth Sciences*, 83, 1–26.
- Mittlefehldt D.W., Miller C.F. (1983): Geochemistry of the Sweetwater Wash Pluton, California: implications for “anomalous” trace element behaviour during fractionation of felsic magmas. *Geochim. Cosmochim. Acta*, 47, 109–124.
- Yurimoto H., Duke E.F., Papike Y.Y., Shearer C.K. (1990): Are discontinuous chondrite-normalized REE patterns in pegmatitic granitic systems the results of monazite fractionation? *Geochim. Cosmochim. Acta*, 54, 2141–2145.