FLUID INCLUSION AND STABLE ISOTOPE EVIDENCE ON METALLOGENESIS OF SANTA BÁRBARA GRANITIC MASSIF, RONDÔNIA TIN PROVINCE, BRAZIL

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The Santa Bárbara granitic massif is part of the Younger Granites of Rondônia (998-974 Ma), composed of granitic rocks with geochemical characteristics of within-plate A-type rapakivi granites. It comprises three subsolvus units, emplaced into medium to high-grade metamorphic rocks (1.75 and 1.50 Ga). The latest unit, called Santa Bárbara facies association, hosts tin mineralization and is composed by two albite-microcline granite facies, with transitional contacts: a pink-medium grained pyterlite, and an even-grained to porphyritic pink-whitish to white fine-grained granite restricted to the granite cupola system, both described as peraluminous in character. Zinnwaldite is the dominant mafic mineral, while fluorite, topaz, zircon, thorite, cerianite, columbite, La-Nd-Y oxides and cassiterite are the accessory mineral phases. The tin mineralization covers a 500 m by 150 m zone, and is mainly expressed by horizontal to subhorizontal lens-shaped topaz-zinnwaldite-quartz greisens (up to 40 m thick). The hydrothermal alteration, which affected the granites, can be divided into: 1) pervasive alteration style which is represented by the lens-shaped bodies of greisen (0.5% SnO_2) (greisenization I), besides greisenized granite and salmon albitized granite (sodic feldspathization); 2) pervasive fissural alteration style, well exemplified by greisenization II, silicification I, muscovitization, silicification II and argillization, which encompass morpho-structural bodies, such as: cassiterite-bearing topaz-zinnwaldite-quartz greisen stockwork, and cassiterite-quartz veins, muscovite veins, barren-quartz veins and argillic stockwork. The pervasive-alteration metasomatites are spatially related, alternate with each other and exhibit gradational contacts, denoting a concordant layering in relation to the granite upper contact, which defines a bedded greisen cupola model. The structures generated by the fissural alteration are vertical to subvertical and mainly developed within the fine-grained Santa Bárbara facies. The mineralizing fluids are dominantly magmatic, aqueous-carbonic and have salinities varying from 6 to 14 wt% NaCl eq., but low-salinity (1 to 3 wt% NaCl eq.) meteoric fluids partly mixed with magmatic fluids are largely confirmed at the end of the pervasive alteration and mainly during fissural alteration. Immiscibility conditions prevailed in the system at temperatures varying from 370 to 390°C. Oxygen isotope data for quartz-pods and lens-shaped greisens indicate temperatures of the order of 570°C and 500°C, respectively, for the ore genesis. The crystallization temperature for the cassiterite-quartz veins is 415°C. The calculated $\delta^{18}O_{H2O}$ of the tin-bearing fluids in equilibrium with host metasomatites ($\delta^{18}O_{H2O}$ = 5.2 to 7.3‰; quartz-water pair) indicates that the fluids equilibrated with an evolving residual granitic magma or with a high temperature albite-granite, consistent with a magmatic origin. The $\delta^{18}O_{H2O}$ deduced from the equilibrium mica-water indicates mixture with meteoric water, already at the pervasive magmatic-hydrothermal stage ($\delta^{18}O_{H2O}$ = 1.1 to 9.8‰). The late muscovite veins ($\delta^{18}O_{H2O}$ = -6.4‰ at 380°C) and late quartz ($\delta^{18}O_{H2O}$ = -3.8‰ at 380°C) formed at the post-magmatic fissural hydrothermal alteration stage, implying a dominant meteoric water component. Three processes are responsible for cassiterite genesis: 1) immiscibility in conditions of high degree of rock/fluid interaction in lens-shaped greisen bodies and greisen stockwork, 2) boiling of sodic aqueous fluids in cassiterite-quartz veins, and 3) mixing of saline magmatic fluids with high proportions of cold low-salinity meteoric fluids, in muscovite veins.

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