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Fast Track Article

Geochemistry of granitic aplite-pegmatite veins and sills and their minerals from the Sabugal area, central Portugal

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With 19 figures and 12 tables

Abstract: Granitic beryl-columbite-phosphate subtype aplite-pegmatite veins and sills from the Sabugal area intruded a biotite > muscovite granite which is related to another two-mica granite. Variation diagrams of major and trace elements of whole rocks show fractionation trends. REE patterns and $\delta^{18}O$ of whole rocks, BaO and P_2O_5 contents of K-feldspar, anorthite and P_2O_5 contents of plagioclase, major element and Li contents of muscovite and lithian muscovite support this series. Least squares analysis of major elements indicate that the biotite > muscovite granite and aplite-pegmatite veins and sills are derived from the earlier two-mica granite magma by fractional crystallization of quartz, plagioclase, K-feldspar, biotite and ilmenite. Modelling of trace elements shows that magmatic fluxes and fluids controlled the Rb, Sr and Ba contents of aplite-pegmatites, probably also lithium micas (zinnwaldite, polylithionite and rare lepidolite), cassiterite, columbite-tantalite, fluorapatite and triplite. In aplite-pegmatites, lithian muscovite replaces primary muscovite and late lithium micas replace lithian muscovite. Complexely zoned columbite crystals are chemically characterized and attributed to disequilibrium conditions. Relations of granites and aplite-pegmatites and pegmatites from other Portuguese and Spanish areas are compared. The granitic aplite-pegmatites from Sabugal are moderately fractionated and the granitic complex type aplite-pegmatites from Gonçalo are the richest in Li and Sn, derived from a higher degree of fractional crystallization and fluxes and fluids control the Ba and Rb behaviours and Li, Sn, F and Ta concentrations.

Key words: granite, aplite, pegmatite, feldspars, micas, columbite-tantalite, phosphates, modelling.

Introduction

Most pegmatites are derived from granite melts (e.g., Jahns & Burnham 1969, London 2008 and references therein, Simmons & Webber 2008). Major, trace and rare earth elements (REE) and $\delta^{18}O$ of granite, aplite and pegmatite and compositions of their feldspars and micas, particularly muscovite provide significant information on the origin of aplite and pegmatite (e.g. Neiva et al. 2008 and references therein, Wise & Brown 2010, Swanson & Veal 2010, Colombo et al. 2010).

Fluxes like F, P, Li and B in addition to H_2O are present in the origin of rare element pegmatites (London 1992, 2005) and facilitate the rapid growth and cooling which in association with the delayed nucleation cause the pegmatite texture (Nabelek et al. 2010). These fluxes are also responsible for the crystallization of several minerals (e.g. topaz, phosphates, lithium micas and tourmaline) and control the crystallization of others (e.g. cassiterite, columbite-tantalite, microlite) and LIL elements of whole rocks.

The fractional crystallization model for the series of granite and aplite-pegmatite has been rarely applied, but it was successful for major elements, e.g. for Portuguese aplite-pegmatites from Arcozelo da Serra and Gonçalo, which are derived from a granite magma (Neiva et al. 2008, Neiva & Ramos 2010). The Rayleigh fractionation model for trace elements was applied to the granitic aplite-pegmatites from Arcozelo da Serra, which belong to the muscovite-rare element class (MSREL) (Neiva et al. 2008) and Gonçalo aplite-pegmatites belonging to the rare element class (REL), REL-Li subclass, complex type, amblygonite-subtype and lepidolite-subtype (Neiva & Ramos 2010).The individual sills and veins mostly contain both, aplitic and pegmatitic parts, and the term aplite-pegmatites used here refers to these composite veins and sills.

Only a few papers describe chemical zoning in micas and columbite-tantalite minerals involving several ele-

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