Seixigal granite pegmatite (NE Portugal): Structural analysis and general evolution of an outergranite - pegmatite - innergranite stockscheider

M. F. C. PEREIRA[1], C. LEAL GOMES[2] & L. A. AIRES-BARROS[1]

[1]IST-Technical University of Lisbon, mfcp@mail.ist.utl.pt, airesbarros@mail.ist.utl.pt
[2]DCT – Minho University, lgomes@dct.uminho.pt

ABSTRACT

The Seixigal pegmatite complex (Central-Iberian Pegmatite Belt) is an unusual structurally layered body related to the relaxation and collapse evolution of an inner granite-stockscheider-outer granite system. Two main units compose the pegmatite body: horizontal tabular open-filling complex (distal) and ellipsoidal stock (proximal). Emplacement process is conditioned by several episodes of apical dilation and melts recharge, related to collapse at the top of a magma chamber. Late units, besides de normal hydrothermal associations, include resurgent granite compositions.

Keywords: *Central-Iberian Pegmatite Belt, pegmatite, stockscheider, igneous layered structure, boundary layers, resurgent granite.*

INTRODUCTION

The Seixigal (Pereira de Selão) pegmatite belongs to the Variscan Aplite-Pegmatite Province - Central-Iberian Pegmatite Belt (Gomes & Nunes, 2003) in which the miarolitic-ceramic and also rare element categories are predominant (>300-250 My). It is located 4km NE of Vidago (Chaves – NE Portugal) and is one of the largest Portuguese ceramic pegmatites. The mining activity ended in 2000, after depletion of the high grade feldspar reserves. Internal structure and paragenesis of the Seixigal pegmatite are of prime importance for the understanding of oscillatory fractionation mechanisms in residual granitic systems attributable to a collapsing cupola. Most conspicuous aspects are: (1) unusual and expressive layered structure; (2) lithological multiplicity of the sequence of crosscutting veins; (3) presence of several footwall granitoid facies; (4) great structural diversity and mineralogical complexity of independent units. A geometric model for the organization of the system was built up with the data collected from successive exposed fronts, during the 1985-2000 period of mining operations and was confirmed with a small drill-hole program (Pereira *et al.*, 1998, 1999).

GEOLOGICAL SETTING

The Seixigal pegmatite is located in the SW border of a small (≈3 km^2) granite outcrop (Santa Bárbara Pluton - SBP), which intrudes metasediments of Silurian age. The surrounding "schist/granite complex" (Teixeira & Medeiros, 1969) is characterized by migmatization and silicification. The regional granites belong to the two mica type (SBP coarse grained muscovite granite) and biotite rich facies, represented by the Vila Pouca de Aguiar Massif (VPAM). The first are mesozonal (12-15 km), syn- to late-tectonic, geochemically evolved (Li, Rb, Sn) and belong to S type category. The latest are epizonal (6-8 km), late- to post-tectonic, derived from heterogeneous lower crustal materials and express possible contribution of mantle magmas, being poorer in litophile incompatible elements (Neves & Godinho, 1999). Regional foliation trends NW-SE being deflected by granites intrusion. The inferred low pressure metamorphism is related to the granitic intrusions (silimanite/andalusite – biotite – chlorite zones, in pelitic rocks).

DESCRIPTIVE ANALYSIS

1. Shape and size

The Seixigal pegmatite comprises two main domains: an irregularly shaped lensoid to tabular subhorizontal body (≈ 200m maximum length in the W-E direction, and 20 m average height) and a peripheral ellipsoidal stock (the maximum and minimum axes being about 100 m and 40 m respectively) comprising gigantic quartz crystals. The pegmatite shows a discordant sharp contact with the metasedimentary country rocks and a transitional footwall contact (≈ 565m level) into an innergranite unit. The metasomatic border is rich in biotite and andalusite (sericitized) porphyroblasts, and is intersected by quartz or quartz-muscovite-tourmaline veins. A small pegmatite stock was extracted in the footwall bellow the 565m level and a small tabular satellite body was identified to the N of the quarry.

2. Internal structure

a. Layered structure (typical vertical cross section)

From top to bottom the layered sequence includes: metasomatized country rocks, outer-granite facies (< 3m), several pegmatitic layers (pegmatite s.s.) and inner-granite lithological composites. The outer-granite layer appears to be a chilled margin. The contact granite (top) is fine to medium grained, potassic and strongly peraluminous (biotite and andalusite rich). The pegmatite domain is not regularly zoned. Instead, the successive pegmatite layers/bands are homogeneous, essentially composed of perthite and quartz. The bands and their enclosed crystals (including biotite and apatite) become thicker in the footwall direction and are separated by thinner and granular biotite rich layers. The singular bands exhibit a high degree of structural organization. Crystal growth of quartz is typically subvertical and descending, and the bands consist almost in comb perthite or gigantic graphic perthite-quartz assemblages. This is interpreted as the result of heterogeneous in situ crystallization of successive pegmatite melt supply corresponding to an open-filling sequence in a domain situated far from the feeder stock.

b. Proximal stock

The stereographic projection of "c" axes of the quartz gigacrystals in successive topographic levels of the proximal stock also shows a vertical tendency with a terminal and helicoidal rotation of the quartz tips. This aspect is interpreted as a result of in flux crystallization and viscous transport attributed to melt feeding emerging from a proximal zone or stock domain. The lateral contact of this unit is abrupt (at the E side of the body).

c. Innergranite composite

The biotite rich innergranite composite is structurally and compositionally very complex and is interpreted as the result of a granite/pegmatoid/pegmatite oscillatory formation. These units include biotite rich granite (innergranite), felsic differentiates, plumose structures, pegmatite segregations and complex structures typical of mingling and diffusion mechanisms. The intrusion of late innergranite veins between the pegmatite bands and crosscutting the main layering is responsible for the structural complexity and lower quality of feldspar ceramic materials. Compared to the outergranite facies and the average modal composition of the pegmatite body the innergranite and its fractionation products are albite richer. Two porphyry granite veins crosscut the innergranite and the main pegmatite body.

d. Late units

The late units defined in this system include miarolitic cavities, thin veins, hydraulic breccias and replacement masses. The miarolitic assemblages include quartz, microcline, albite, apatite and muscovite and, to a lesser extend, tourmaline. Quartz + tourmaline + feldspar veins are the most common whereas the quartz + albite + cassiterite veins and cassiterite aplites are very rare. Breccias composed of apatite + quartz + pyrite or clorite + albite + pyrite ± sphalerite ± Al-tantite ± Na-tantite are locally important. A rare quartz + apatite + phenakite ± bertrandite ± OH-herderite assemblage is found in some filling cavities at the eastern and larger hydrothermal breccia. The chloritization and sericitization is widespread in all units, including the enclosing rocks. The late fractionation of the system show a quartz-albite trend enriched in F, P, B and S minerals.

PEGMATITE EMPLACEMENT AND EVOLUTION

The emplacement and evolution models are established appealing to the kinematics of crystallization and deformation, in a brittle and melt flow regime at the cupola of a magma chamber. The shape and orientation of the pegmatite body is concordant to the most evolved innergranite. This fact can be attributed to an enrichment of volatiles (F, P, B and S) at the highest levels of the granite paleocupola (Gomes & Nunes, 2003). Little deformation of the host-rocks (small expansion and little rotation, inferred by schistosity measurements), sharp contacts and the existence of few xenoliths inside the pegmatite are indicative of permissive intrusion or magmatic stopping. In such dilatational environment the proximal stocks worked like feeder volumes and the layered domains correspond to a crack and seal compartment, cyclically reactivated. The existence of subhorizontal panels connected to subvertical innergranite channels reveals the maintenance of the relaxation regime at the granite cupola after the pegmatite consolidation. The geometric/kinematic and compositional relations suggest an outergranite → pegmatite → innergranite emplacement sequence and a correlated chemical evolution, independent of the SBP granite (Pereira *et al.*, 1998). The late units, derived from pegmatite residual melts and innergranite differentiates, are emplaced in a typical brittle regime and crosscut the earliest layering. These late units are also intersected by major faults with regional orientation, which focused the hydrothermal circulation.
The geometry of the system indicates an emplacement essentially related to a low viscosity and volatile rich granitic magma in a collapsing cupola. This situation is highly favourable to the stockscheiders formation, in which vertical relaxation is easily recognized in some of the internal structures. Narrow inter-layered felsic or biotite rich horizons observed in the innergranite composite are considered to be the result of the definition of thermo-gravitational differentiation panels. Consequently, late biotite facies could result from final granite resurgence. The composition of the late paragenesis suggest that the system reached paroxysmal volatile pressures capable of hydraulic fracturing and brecciation.

ACKNOWLEDGMENTS

PRODEP III Program (5.3– Nº 207.004). PRAXIS XXI Program (2/2.1/CTA/437/94). POCI2010 – Medida II.1 e V.3.

REFERENCES CITED

Gomes, C.L. & Nunes, J.E.L. (2003) – Análise paragenética e classificação dos pegmatitos graníticos da cintura hercínica centro-ibérica, in " A Geologia de Engenharia e os Recursos Geológicos", M. Portugal V. Ferreira (Coord.), Coimbra, Imp. Univ. Ed., Vol. 2, 85-109.

Neves L.J.P.F. & Godinho M.M. (1999) – Structural state of K-feldspar in some hercynian granites from Iberia: a review of data and controlling factors. Can. Miner., 37, 691-700.

Pereira, M.F.C., Gomes, C.L. & Aires-Barros, L.A. (1998) - Análise estrutural e modo de instalação do pegmatito granítico de Pereira de Selão - Vidago (N de Portugal). Actas do V Cong. Nacional de Geologia, Lisboa, 1998. Resumos alargados. Comunic. IGM, 84, nº1, B 43-46.

Pereira, M.F.C., Gomes, C.L. & Aires-Barros, L.A. (1999) – Discriminação composicional das unidades tardias do pegmatito de Pereira de Selão – Vidago - Norte de Portugal. Actas II Congresso Ibérico de Geoquímica/XI Semana de Geoquímica. Lisboa, Portugal, 273-276.

Teixeira, C. & Medeiros, A.C. (1969) - Folha 6-B (Chaves) da carta geológica de Portugal à escala 1:50 000, Serviços Geológicos de Portugal.