UNIVERSIDADE DE SÃO PAULO

INSTITUTO DE GEOCIÊNCIAS

The meaning of oxidized A-type post-orogenic granitic magmatism: Petrogenesis of the Itupeva Pluton, Itu Batholith, SE Brazil.

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Orientador: Prof. Dr. Valdecir de Assis Janasi

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DEDICATION

To my loving and unconditional family.

RESUMO

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Neste trabalho, um estudo integrado de petrografia, composição mineral, geoquímica de rocha total e isótopos Sr e Nd foi realizado para o Pluton Itupeva. Este plúton pertence ao Batólito Itu, que é a ocorrência mais expressiva de rochas graníticas com afinidade tipo A na Província Granítica Itu pós-orogênica, São Paulo, Brasil, e é composto principalmente por granitos, com rochas quartzo monzodioríticas subordinadas ocorrendo como diques sin-plutônicos e enclaves microgranulares. Os granitos são magnesianos, cálcio-alcalinos de alto K, e metaluminosos a levemente peraluminosos e são classificados como granitos tipo A oxidados. As características geoquímicas importantes são um enriquecimento em elementos litófilos (LILEs) e elementos de terras raras leves (LREEs), com anomalias de Eu negativas (Eu / Eu * = 0,47-0,58) e um empobrecimento relativo em elementos de alta intensidade de campo (HFSEs), refletida em anomalias negativas de Nb e Ti. Os quartzo monzodioritos associados são metaluminosos e têm padrões ricos em REE que são subparalelos aos dos granitos, compartilhando com eles algumas outras características geoquímicas importantes, como enriquecimento em Rb, Ba, K e LREE, e empobrecimento em Nb e Ti. Junto com assinaturas isotópicas de Sr-Nd semelhantes, as observações são sugestivas do caráter comagmático para granitos e quartzo monzodioritos.

Características macro e microestruturais, como a ocorrência de diques sin-plutônicos e enclaves microgranulares com quartzo e feldspato alcalino reabsorvidos e manteados, e a presença local de estruturas de back-veining, indicam que os quartzo monzodioritos cristalizaram de um magma que foi injetado e misturado com os mushes graníticos no nível de colocação, induzindo localmente alguma refusão.

A petrologia integrada e a geoquímica elementar e isotópica sugerem que os granitos e quartzo monzodioritos foram gerados pela interação de magmas derivados do manto e fundidos crustais no MASH (melting, assimilation, storage, homogenization) ou "hot zone" em níveis crustais profundos. Durante a ascensão para níveis crustais mais rasos, esses magmas arrastaram antecristas (por exemplo, plagioclásio com alto e baixo teor de anortita nos quartzo monzodioritos, biotita de alto bário em granitos) derivados de reservatórios de magma ricos em cristais. Nesse cenário, sugerimos uma evolução do magma em reservátorios de magma interconectados ricos em cristais e localizados em diferentes níveis crustais. A variação

composicional e mineralógica apresentada no plúton Itupeva registra múltiplos processos de evolução do magma, incluindo cristalização e acumulação, recarga e remobilização de mushes, mixing e mingling, assimilação e carreamento de antecristas, que operaram ao longo de um sistema magmático transcrustal.

Palavras-chave: Petrogenesis, cogeneticos, antecristais, MASH, rservatórios de magma, sistemas magmpaticos transcrustais

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1 INTRODUCTION

It is well known that A-type granites are formed in a variety of extension-related tectonic settings, such as continental arc or backarc extension to post-collisional extension and within-plate settings (e.g., Eby 1992; Dall'Agnol et al. 2012). They therefore have been subjected to several studies because their petrogenesis provides important information on post-collisional/intraplate extensional magmatic processes within the continental lithosphere (Turner et al., 1992; Mushkin et al., 2003). Although several models have been proposed to describe and explain the formation and geological significance of A-type granites, their genesis is still a matter of many discussions. These models include (1) extreme fractional crystallization of mantle-derived tholeiitic or alkaline basaltic magmas; (2) low-degree partial melting of lower-crustal granulites with depletion of incompatible elements; (3) anatexis of underplated I-type tonalitic crustal source; and (4) hybridization between crustal and mantle-derived magmas, such as crustal assimilation and fractional crystallization of mantle-derived magmas, or of mixing between mantle-derived and crustal magmas (e.g. Collins et al., 1982; Whalen et al., 1987; Creaser et al., 1991; Turner et al., 1992; Eby 1990, 1992; Patino Douce 1997).

The magmatism associated to the post-orogenic/post- collisional period is characterized by the occurrence of plutons formed by undeformed granites, which usually have "A- type" characteristics and are associated with contemporary basic manifestations. The compositional diversity in granites may be controlled by different factors and processes, as source compositions, variable melting conditions (e.g. temperature, pressure/depth, water and oxygen fugacity), the degree of partial melting and fractional crystallization, assimilation and magma mixing and mingling (e.g. Patiño Douce, 1999; Barbarin, 2005; Stevens et al., 2007; Clemens et al., 2009; Clemens and Stevens, 2012). Although these compositional variations may occur during different stages of formation, from the source to final emplacement, it remains controversial as to which is the dominant process responsible of the chemical diversity of the granitic bodies.

Furthermore, the coexistence in space and time between granites and mafic/intermediate magmas increases the key issues concerning to the role of mantle derived materials and its interactions with lower to middle crust: granites could be generated from partial melting of crustal rocks or young underplated basalts by heat advection from mantle-derived magmas; or fractionation of mantle-derived magmas, associated or not with partial melting of crustal rocks, crustal assimilation coupled with fractional crystallization (AFC) and/or magma mixing (e.g., Whalen et al., 1987; Bonin, 2007).

The Itu batholith is one of the most expressive occurrences of the Itu Granitic Province, which is characterized by its unique character in the context of the Neoproterozoic tectonic evolution of southeast Brazil, given the presence of a considerable diversity of plutonic rocks: A- type granites of the aluminous series and calc-alkaline granites, besides abundant bodies of basic composition. Especially, in the Itu Batholith, the granites from the Itupeva pluton are spatially, temporally, and chemically associated with quartz monzodioritic bodies -as microgranular enclaves and syn- plutonic dykes- in the center of the pluton. Therefore, it provides an excellent case study for examining the genetic relationship between the spatially and temporally associated mafic and felsic rocks. In this work, a comprehensive study including petrological, mineral chemical, whole-rock geochemical and Sr-Nd isotopic analyses from the granites and quartz monzodiorites of the Itupeva pluton have been carried out to investigate the evolution process of the Itupeva magma system and to investigate the relationship between both rock types.

1.1 Objectives

- Use the petrographic, geochemical and mineral chemical information to establish the petrogenetic links between granites and quartz monzodiorites in the Itupeva pluton and thereby to reconstruct the whole magmatic system in which they were generated and evolved.
- Present a comprehensive study of in situ major and trace elements of minerals (plagioclase, biotite, hornblende, zircon and apatite) hosted in the dominant facies of Itupeva pluton, in order to contrast the rock-forming conditions estimating crystallization parameters prevalent during the petrological evolution of this pluton.

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