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Petrogenesis of the Puerto Edén Igneous and Metamorphic Complex, Magallanes, Chile: Late Jurassic syn-deformational anatexis of metapelites and granitoid magma genesis

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Abstract

A suite of schists, gneisses, migmatites, and biotite granitoids from the Puerto Edén Igneous and Metamorphic Complex (PEIMC) and biotite–hornblende granitoids of the South Patagonian batholith (southern Chile) has been studied. For that purpose, the chemistry of minerals and the bulk rock composition of major and trace elements including Rb–Sr and Sm–Nd isotopes were determined. Mineralogical observations and geothermobarometric calculations indicate high-temperature and low-pressure conditions (ca. 600–700 °C and 3 to 4.5 kbar) for an event of metamorphism and partial melting of metapelites in Late Jurassic times (previously determined by SHRIMP U–Pb zircon ages). Structures in schists, gneisses, migmatites and mylonites indicate non-coaxial deformation flow during and after peak metamorphic and anatectic conditions. Andalusite schists and sillimanite gneisses yield initial $^{87}Sr/^{86}Sr$ ratios of up to 0.7134 and εNd_{150} values as low as − 7.6. Contemporaneous biotite granitoids and a coarse-grained orthogneiss have initial $^{87}Sr/^{86}Sr$ ratios between 0.7073 and 0.7089, and εNd_{150} values in the range − 7.6 to − 4.4. This indicates that metamorphic rocks do not represent the natural isotopic variation in the migmatite source. Thus, a heterogeneous source with a least radiogenic component was involved in the production of the biotite granitoids. The PEIMC is considered as a segment of an evolving kilometre-sized and deep crustal shear zone in which partial melts were generated and segregated into a large reservoir of magmas forming composite plutons in Late Jurassic times. A biotite–hornblende granodiorite and a muscovite–garnet leucogranite show initial $^{87}Sr/^{86}Sr$ ratios of 0.7048 and 0.7061, and εNd_{100} values of − 2.6 and − 1.8, respectively, and are thus probably related to Early Cretaceous magmas not involved in the anatexis of the metasedimentary rocks.

Keywords: Metapelites; Migmatites; Sr–Nd isotopes; Late Jurassic; Gondwana

1. Introduction

The formation of anatectic migmatites with pelitic or psammopelitic protoliths involves mainly muscovite and/

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or biotite dehydration-melting reactions, with or without fluid influx, and partial melt back-reactions (e.g. Spear et al., 1999; Kriegsman, 2001; Milord et al., 2001; Otamendi and Patiño Douce, 2001). If deformation and melting are coeval, melts could move through the rocks by cyclic inflation and collapse of conduits, caused by build-up of melt pressure and periodic draining of the source (e.g. Brown and Solar, 1998; Weinberg, 1999). Melt segregation from the site of partial melting is followed either by in situ crystallisation, or by the later crystal fractionation and mobilisation of chanellised liquids with more evolved compositions (Milord et al., 2001). The study of these and corresponding processes is of special interest because of their inferred role as a link between high-grade metamorphism and the generation of larger-scale granitic bodies (e.g. Brown and D'Lemos, 1991; Solar and Brown, 2001).

Migmatites typically consist of lighter, intermediate and darker parts, usually named leucosome, mesosome and melanosome, which can be related to metamorphic and magmatic processes. The leucosome is considered to be the crystallisation product of an in situ felsic melt modified by cumulate products of partial crystallisation

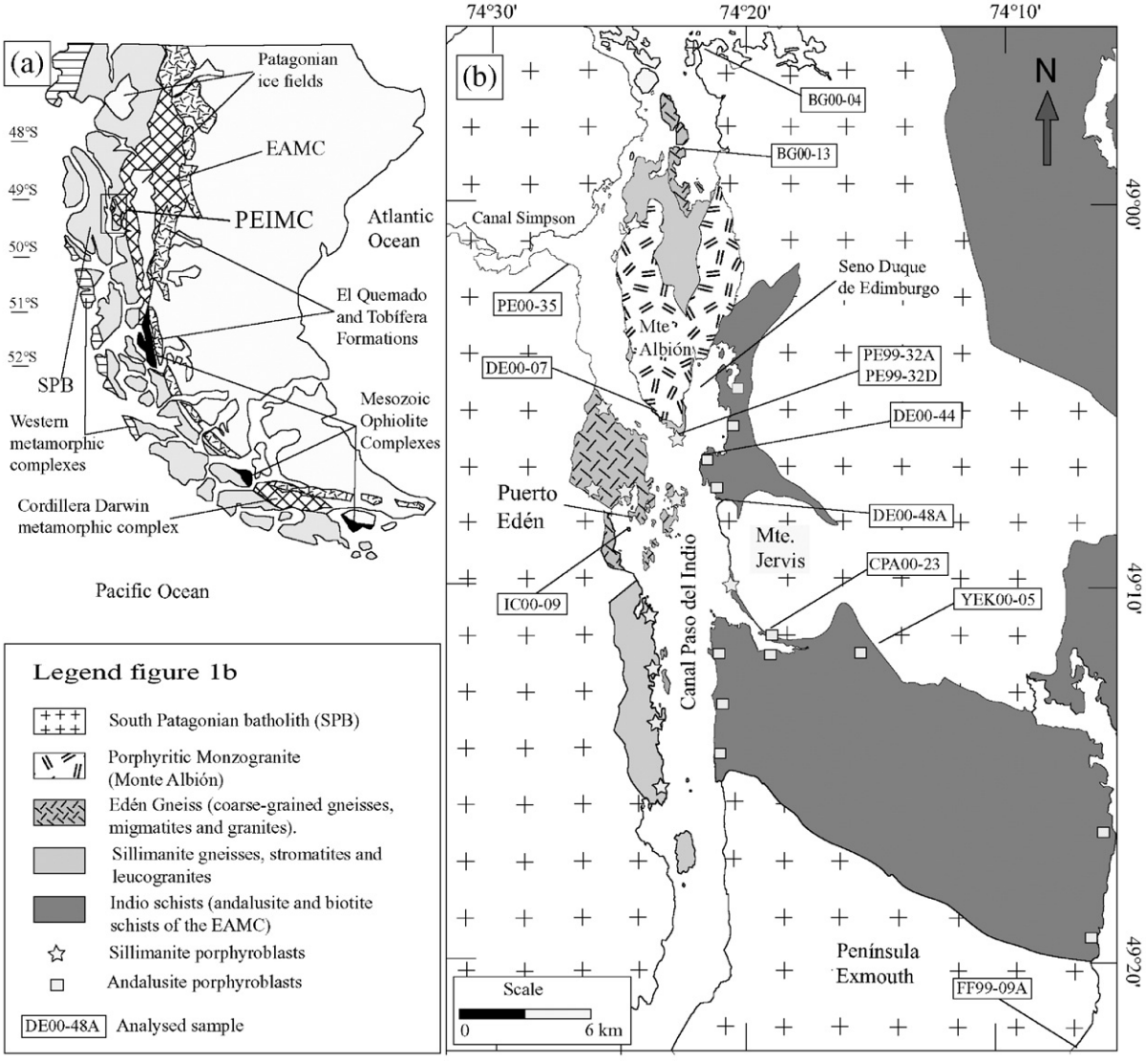

Fig. 1. (a) Location map of the southwestern Patagonian geological units (modified from Pankhurst et al., 1998). Eastern belt of metamorphic rocks are the Eastern Andean Metamorphic Complex (EAMC) and the Cordillera Darwin metamorphic complex; South Patagonian Batholith (SPB); Puerto Edén Igneous and Metamorphic Complex (PEIMC); Mesozoic ophiolite complexes (Late Jurassic–Early Cretaceous), oceanic-type mafic floor remnants of the Rocas Verdes basin. (b) Geological map of the PEIMC and surrounded areas (modified from Watters, 1964). Localities and studied samples are indicated.