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Permian, rifting related fayalite syenite in the Panxi region, SW China

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Abstract

Within the Panxi rift of the Permian Emeishan large igneous province (ELIP), SW China, a 20 km^2 quartz-bearing fayalite syenitic pluton intrudes the 260 Ma Baima igneous complex (BIC). The fayalite syenite is dated using SHRIMP zircon U–Pb techniques at 252±2.5 Ma. The Panxi fayalite syenite is mainly composed of alkali feldspar, ferroan augite, fayalite, quartz and Fe–Ti oxides and contains 61.8–63.7 wt.% SiO_2, 5.0–7.3 wt.% Fe_2O_3t and 9.9–12.1 wt.% total alkalis, belonging to an A-type variety of ferroan alkalic metaluminous granitoids. The fayalite syenite displays positive Eu anomalies (Eu/Eu* = 0.9–8.9) and is enriched in LREE [$(La/Yb)_N$ = 6.6–11.5]. The εNd values and $(^{87}Sr/^{86}Sr)_{initial}$ ratios of the fayalite syenite range from +1.3 to +1.9 and from 0.7035 to 0.7068, respectively. The fayalite syenite and the BIC had the same mantle source; however the 8 myr age gap between them suggests the fayalite syenite formed by remelting of underplated mafic magmas injected into the crust during ELIP magmatism. The ages of the fayalite syenite and BIC are coincident with two Permian mass extinction events and suggest that ELIP may have influenced both.

Keywords: Syenite; Fayalite; A-type; Emeishan large igneous province; SHRIMP zircon dating

1. Introduction

Continental rifting or extensional environments are common sites of alkalic and alkaline igneous rocks including A-type granites (Bailey, 1974; Eby, 1990). 'A-type' granites are commonly related to anorogenic tectonic setting but not exclusively (Nyman et al., 1994). They are characterized by high Fe/Mg and K/Na ratios and high K_2O contents and rich in incompatible elements, rare earth elements (REE), Zr, Nb and Ta but poor in Co, Sc, Cr, Ni, Ba, Sr and Eu (Loiselle and Wones, 1979). They are thought to form under low H_2O and low fO_2 conditions and minimum liquidus temperatures between 900 and 1000 °C (Clemens et al., 1986; Creaser and White, 1991).

The origin of some A-type granites remains uncertain, they could be related to at least three mutually exclusive processes 1) crustal melting (Collins et al., 1982; Clemens et al., 1986; Whalen et al., 1987; Creaser et al., 1991), 2) differentiation of mantle-derived basalts, whether this is from fractionation of anorthosite residual melts or direct fractionation of basalts may be case specific (Morse, 1982; Olson and Morse, 1990; Weibe, 1992; Mitchell et al., 1995, 1996; Frost and Frost, 1997; Vander Auwera et al., 1998, Frost et al., 1999), and 3) mantle-derived magmas contaminated by the crust (Poitrasson et al., 1995; Anderson et al., 2003).

There are numerous A-type granitoids within the late–middle Permian Emeishan large igneous province

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(ELIP) of SW China. Most of these A-type granitoids are peralkaline quartz syenites or peralkaline granites spatially and temporally associated with layered mafic–ultramafic intrusions that host giant magmatic Fe–Ti–V oxide deposits (Zhou et al., 2005; Shellnutt et al., 2005). In this assemblage we identify an unusual occurrence of a fayalite, ferroan augite-rich and quartz-bearing syenite. Granitic rocks of broadly similar composition and mineralogy to the fayalite syenite have been documented throughout the geological record; in fact they are most commonly, but not exclusively, related to anorthosite formation and are rarely reported from large igneous provinces (Morse, 1969; Ashwal, 1993; Frost and Frost, 1997). This occurrence of a fayalite-bearing syenite gives us opportunity to examine the genesis of such rocks outside of their usual setting. The fayalite syenite is dated at 252±2.5 Ma using the SHRIMP zircon U–Pb method, thus being part of the ELIP (Zhou et al., 2002c; Fan et al., 2004). This is the only known occurrence of such a rock in the entire ELIP. In this paper we report whole rock elemental and Sr–Nd isotopic data in an attempt to determine the petrogenesis of the fayalite syenite and its temporal implications for the ELIP.

2. Geological background

South China comprises the Cathaysian Block to the southeast and the Yangtze Block to the northwest and is bounded to the west by the Tibetan Plateau (Fig. 1). Mid-Proterozoic granitic gneisses and metasedimentary rocks are exposed along the western margin of the Yangtze Block. Intruding the mid-Proterozoic rocks are Neo-Proterozoic calc-alkaline arc-related granites and associated mafic rocks. The Neo-Proterozoic rocks are part of a continuous belt extending over 1000 km from the southwest to the northeast (Zhou et al., 2002b). These rocks are overlain by a younger cover sequence of Upper Sinian (600 Ma) Dengying Formation limestone and Cambrian to Triassic clastic sedimentary and volcanic rocks (Yan et al., 2003).

During the late–middle Permian (260 Ma), extensive magmatism formed voluminous continental flood basalts, felsic plutons and layered mafic–ultramafic

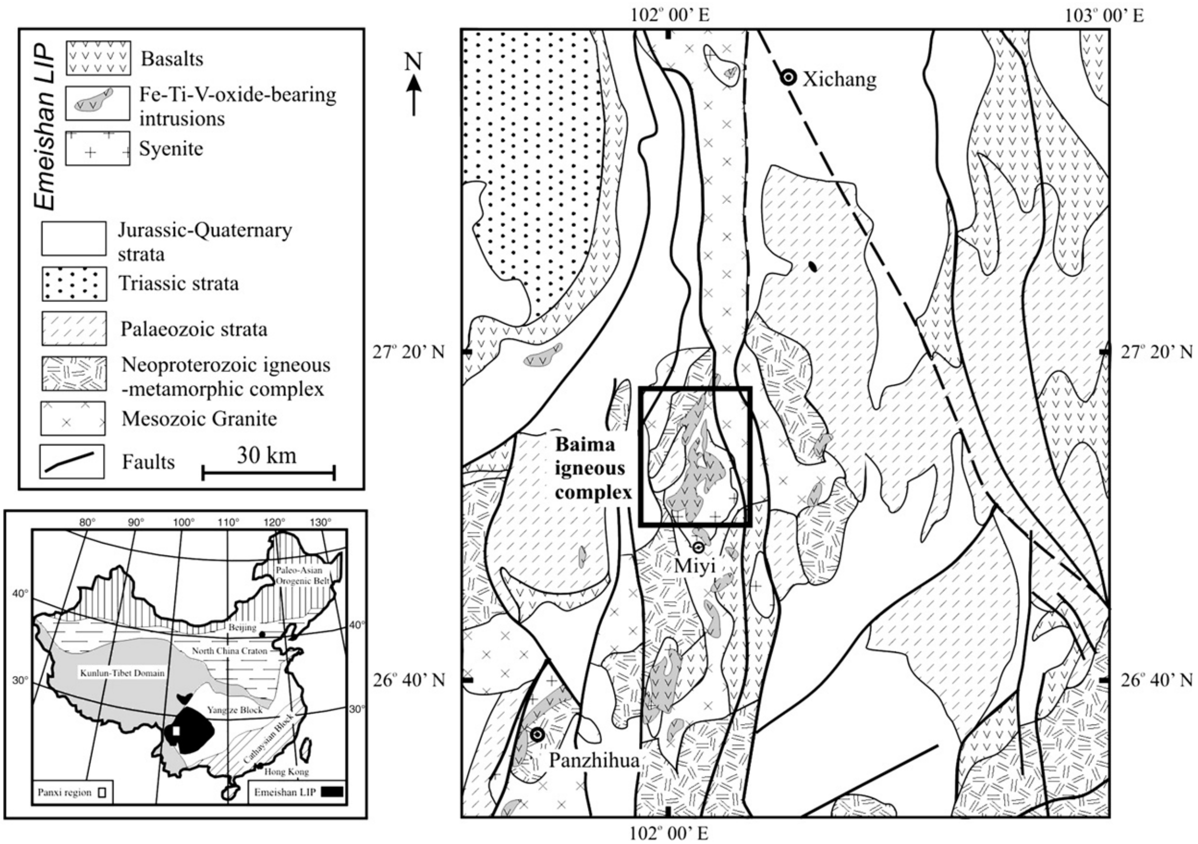

Fig. 1. Local geological map of the Panxi region showing the distribution of mafic and felsic plutonic rocks. The boxed area is shown in Fig. 2 (modified from Zhou et al., 2005).