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Implications for Rodinia reconstructions for the initiation of Neoproterozoic subduction at ~860 Ma on the western margin of the Yangtze Block: Evidence from the Guandaoshan Pluton

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ABSTRACT

Neoproterozoic igneous rocks are widespread along the western margin of the Yangtze Block, but their petrogenesis and tectonic setting is debated. The Guandaoshan pluton is located at the southwestern margin of the Yangtze Block and is mainly composed of diorite and subordinate gabbro, with quartz diorite in its margin. Hornblende is an ubiquitous mineral in different phases of the pluton. SHRIMP zircon U–Pb dating of quartz diorite, gabbroic diorite, and gabbro from the pluton yielded $^{206}Pb/^{238}U$ ages of 857 ± 7 Ma, 856 ± 6 Ma, and 856 ± 8 Ma, respectively. Guandaoshan pluton samples show a large range of SiO_2 (47.02–67.66%), MgO (1.12–7.5%), $Fe_2O_3^T$ (2.8–12.22%) and CaO (2.95–11.88%), low rare earth element (REE) contents from 22 to 49 ppm, and enrichment of Sr, Ba and Rb and depletion of Nb, Zr and Ti with characteristics of island arc magma. They also exhibit low initial $^{87}Sr/^{86}Sr$ ratios from 0.7030–0.7033, and positive $\varepsilon_{Nd}(t)$ values from +4.8 to +5.2. These features suggest that the parental magma of the Guandaoshan pluton originated at a convergent plate boundary from a depleted mantle source modified by slab fluids, and underwent the fractional crystallization of amphibole and magnetite, without significant crustal assimilation, during the formation from gabbro–diorite to quartz diorite. Neoproterozoic magmas with age of 860–740 Ma are abundant on the western Yangtze Block, and there is a gap of magmatism in early Neoproterozoic (from about 1000 Ma to 870 Ma). Therefore, it can be deduced that the ~860 Ma Guandaoshan pluton and the contemporary magmatism represent initial subduction at the western margin of the Yangtze Block. Based on the Neoproterozoic paleomagnetic data, detrital zircon ages, magmas with low $\delta^{18}O$ values in South China and our new data, we prefer that the South China Block was located at the margin of Rodinia in the Neoproterozoic, and not at the center of the supercontinent.

1. Introduction

Ancient supercontinent reconstruction is one of the foci of Precambrian research (Li et al., 2008; Rogers and Santosh, 2002, 2003; Zhao et al., 2002, 2004). Over the last twenty years, South China, including the Yangtze and Cathaysian Block, has been considered a key area for understanding the Neoproterozoic Rodinia supercontinent (Li et al., 1995, 1996, 2002a, 2003b; Yan et al., 2002; Zheng et al., 2007, 2008; Zhou et al., 2002a,b, 2006a). In particular, the origin of large volumes of Neoproterozoic 860 to 745 Ma magmas widely distributed across the Yangtze Block is crucial for understanding the Precambrian tectonic evolution of the Yangtze Block and establishing the location of South China in Rodinia. There are two divergent opinions on the petrogenesis and tectonomagmatic affiliations of these voluminous igneous rocks. Li et al. (1999, 2002a,b, 2003a,b,c, 2011) and Wang et al. (2007a, 2008, 2011) considered them as rift-related and produced by a mantle plume beneath the Rodinia supercontinent. On the other hand, Yan et al. (2002) and Zhou et al. (2002a,b) proposed that they formed in an island arc environment along the northern and western margin of the Yangtze Block, and Wang et al. (2004, 2006) suggested that they may be related to collisional process in the southeastern Yangtze Block.

The western margin of the Yangtze Block is characterized by volumetrically dominant Neoproterozoic felsic intrusive rocks with subordinate mafic and intermediate rocks. Previous research mainly

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concentrated on the mafic and felsic rocks in this region, but paid little attention to the intermediate rocks. The Guandaoshan pluton, located at the southwestern margin of Yangtze Block, is composed dominantly of diorite with local gabbro and quartz diorite. Li et al. (2003b) considered the intrusion to be the initial expression of mantle plume magmatism that leads to the breakup of Rodinia. On the other hand, Sun and Zhou (2008) proposed that it is a typical Cordilleran-type granitoid produced by oceanic-plate subduction on a continental margin. Previous research was mainly concentrated on the diorite and quartz diorite in the pluton (Geng et al., 2008; Li et al., 2003b; Sun and Zhou, 2008). In this contribution, we present petrological, geochronological, geochemical and Sr–Nd isotopic data on the gabbro–diorites and quartz diorites to constrain the petrogenesis and tectonic setting of the Guandaoshan pluton. The new evidence reveals that the Guandaoshan magma is derived from a depleted mantle source modified by subduction zone fluids, and was emplaced in an island arc environment. Significance for the paleogeographic location of South China Block in Rodinia is discussed.

2. Geological background

The western margin of the Yangtze Block, the 'Kangdian axis' of older Chinese geological literature, is one of the most significant regions of Precambrian basement outcrop in China. Previous research suggested that the Precambrian rocks in this region consists of 'crystalline' basement and 'folded' basement, in which Kangding Complexes (including the Kangding Group) are crystalline basement with Neoarchean to Paleoproterozoic ages, and Huili, Kunyang, Dahongshan, Yanjing and Yanbian Groups are folded basement with the ages of Paleoproterozoic to Mesoproterozoic (Cheng, 1994). In the last decade, a large amount of zircon U–Pb data have shown the Kangding Complexes, Yanbian and Yanjing Groups formed in the Neoproterozoic, rather than the Neoarchean to Mesoproterozoic (Chen et al., 2005; Du et al., 2005, 2006, 2007, 2013; Geng et al., 2007a, 2008; Li et al., 2003c, 2011; Liu et al., 2009a; Sun et al., 2008; Zhang et al., 2008; Zhao and Zhou, 2007a,b; Zhou et al., 2002a).

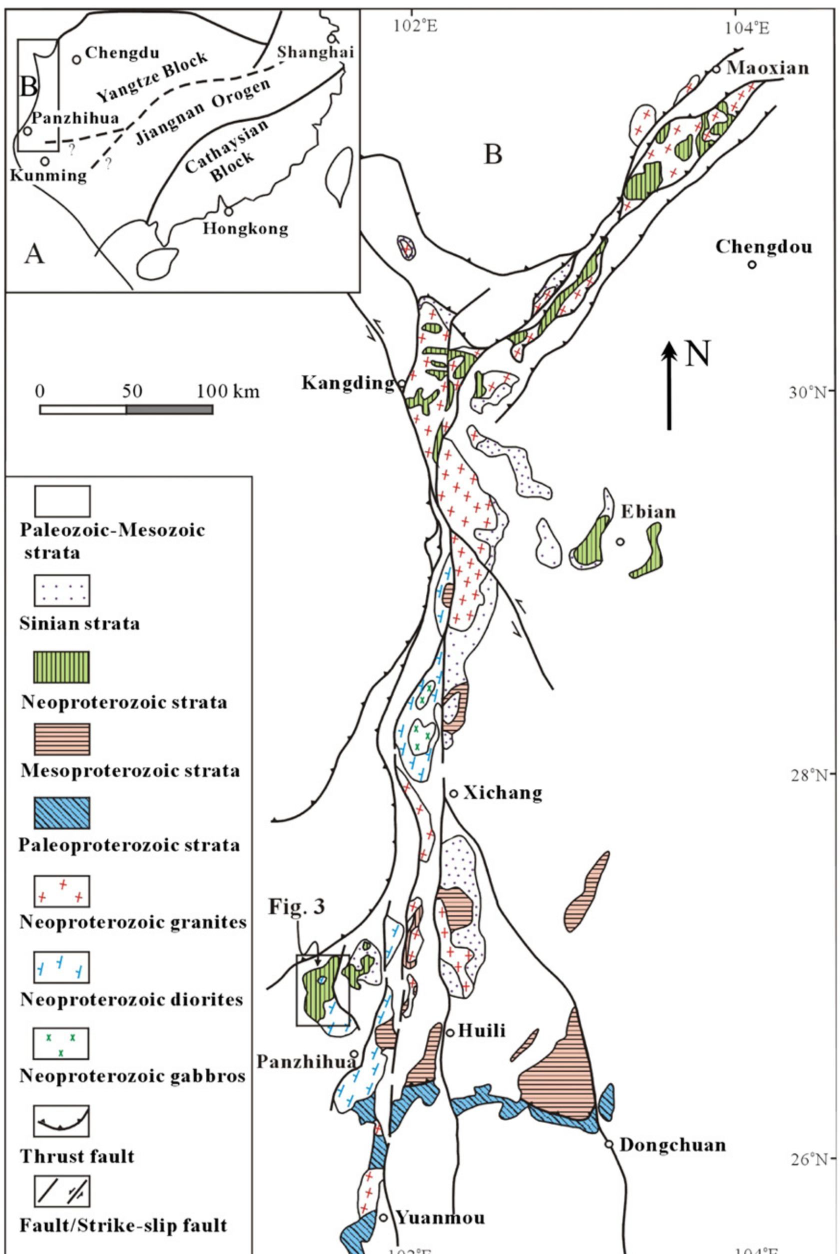

Fig. 1. Geological sketch map of the western Yangtze Block (after Geng et al., 2008). The location map (A) in the upper-left corner is from Yang et al. (2009).