Gondwana Research 19 (2011) 232–243

Contents lists available at ScienceDirect

Gondwana Research

journal homepage: www.elsevier.com/locate/gr

Late Devonian OIB alkaline gabbro in the Yarlung Zangbo Suture Zone: Remnants of the Paleo-Tethys?

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ARTICLE INFO

Article history:
Received 23 October 2009
Received in revised form 9 February 2010
Accepted 23 May 2010
Available online 9 June 2010

Keywords:
Devonian
Yarlung Zangbo suture
Paleo-Tethys
Southern Tibet
SIMS

ABSTRACT

The Yarlung Zangbo Suture Zone (YZSZ) is believed to be composed of material largely derived from the destruction of the Neo-Tethys that occurred from early Mesozoic to early Cenozoic. We report here geochronological and petrological data obtained for newly discovered alkaline gabbro blocks embedded in a mélange zone of the western YZSZ. Single zircon U–Pb analyses from one representative gabbro sample by SIMS (Secondary Ion Mass Spectrometry) yielded a combined crystallization age of about 363.7 ± 1.7 Ma (1σ). *In situ* Hf isotopic analyses yielded $\varepsilon_{Hf}(t)$ values of +2.6 to +5.5, suggesting an enriched mantle source. All of the gabbro samples show typical Ocean Island Basalt (OIB) affinity with little or no continental crust contamination. They also display strong geochemical similarities with the Hawaii basalts and the Xigaze seamount basalts suggestive of their intra-oceanic setting. These observations, in combination with the Early Carboniferous layered gabbros reported at Luobusa, indicate that these rocks could represent remnants of the Paleo-Tethys. We propose that a branch ocean separating the Western Qiangtang terrane and the Lhasa terrane from the Gondwana continent might have been present during the Late Devonian and the Early Carboniferous, providing new constrains on the configuration of Paleo-Tethys in Tibetan Plateau during early Late Paleozoic.

1. Introduction

The Yarlung Zangbo Suture Zone (YZSZ) which locates along the Yarlung river in southern Tibet is accepted to mark the suture between the India to the south and the Lhasa terrane to the north, and thus, is made of remnants largely derived from the destruction of the Neo-Tethys (Fig. 1A; Allègre et al., 1984; Wang et al., 2000; Dupuis et al., 2005; Bédard et al., 2009). These interpretations are consistent with the most frequent ages ranging from 191 to 122 Ma reported so far for ophiolites, related deep-sea sediments and dynamothermal sole of the YZSZ (Table 1; McDermid et al., 2002; Zhou et al., 2002; Miller et al., 2003; Ziabrev et al., 2003; Wang et al., 2006; Wei et al., 2006a, b; Zhong et al., 2006; Xia et al., 2008a; Guilmette et al., 2009; Zhang et al., 2009). Recently, new data from eclogites, and granites in the Lhasa terrane suggest that a branch of the Paleo-Tethys should have occurred at the southern margin of the Lhasa terrane during late Paleozoic (Fig. 1A; Yang et al., 2009; Zhu et al., 2009a,b, 2010). Based on the newly discovered eclogite belt whose protoliths were typical MOR basalts and Carboniferous–Permian island-arc volcanic rocks in the Lhasa terrane, Yang et al. (2009) deduce that a Carboniferous–Permian suture zone, named North Gangdese suture zone (NGSZ), should be invoked, and represents the relicts of the North Gangdese Paleo-Tethys (Fig. 1A). This is confirmed by the research results of Zhu et al. (2009a). Furthermore, they consider that the Lhasa terrane may have been a separate intra-Tethyan oceanic block during the Early to Middle Permian (Zhu et al., 2009a, b, 2010). Zhu et al. (2009b) also argue that the Lhasa terrane was an integral part of the Australian continent in the early Paleozoic. These new observations suggest that the Lhasa terrane has been separated from Gondwana before the Carboniferous and has Australian affinity. However, the lack of direct remnants of Paleo-Tethys within the YZSZ makes this interpretation hypothetic. The relative position of the Lhasa terrane within the Paleo-Tethys and the configuration of the Paleo-Tethys during the early Late Paleozoic are still poorly understood.

In this paper we report new U–Pb age and Hf isotope data from zircons, whole-rock major and trace element data, and mineral geochemistry on the Najiu gabbro samples from the western YZSZ. The data reveal the presence of Upper Devonian OIB alkaline gabbro blocks in a mélange zone of the YZSZ, which show intra-oceanic setting. The new discovery provides additional constraints on the configuration of the Paleo-Tethys during the Late Devonian–Early Carboniferous.

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doi:10.1016/j.gr.2010.05.015

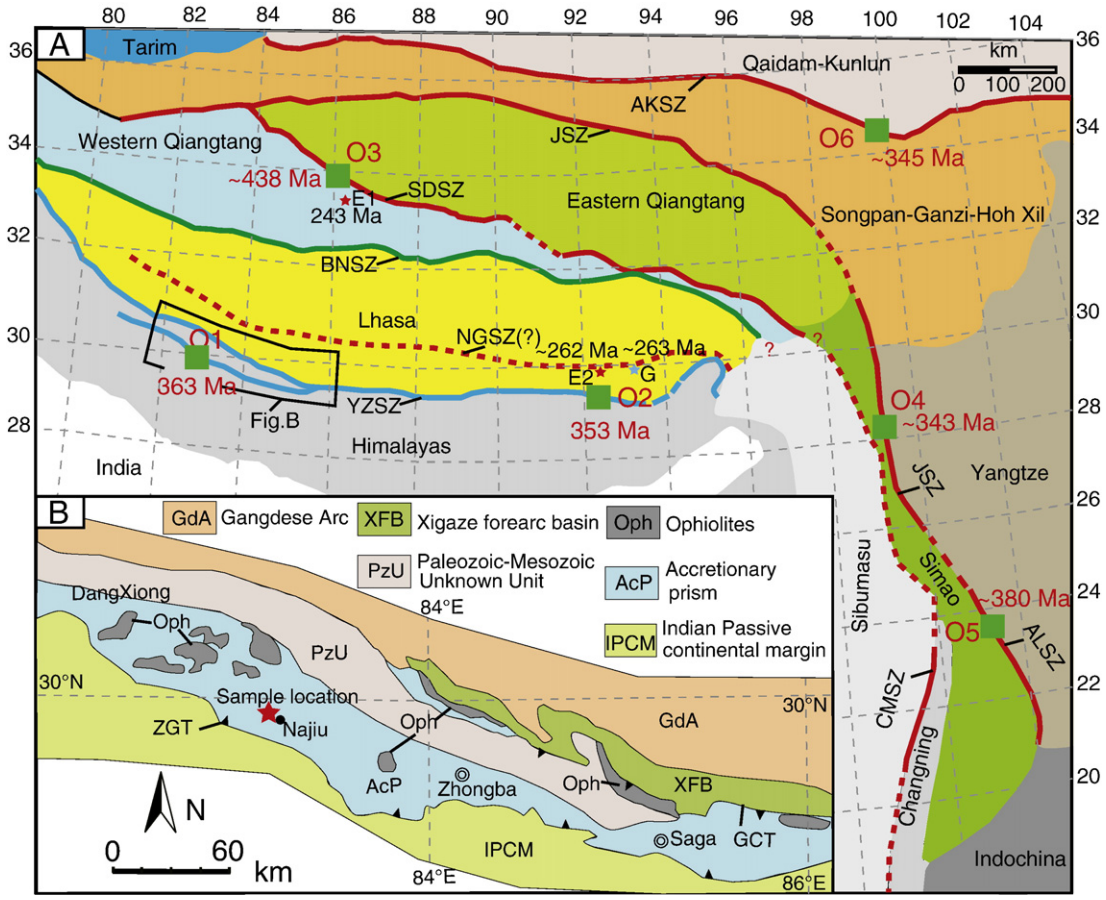

Fig. 1. A: Simplified tectonic map of Tibetan Plateau and Southwest China showing major sutures and radiometric ages obtained from various locations (modified from Yin and Harrison, 2000; Jian et al., 2009a). Major sutures: AKSZ, A'nemaqin–Kunlun suture zone; JSZ, Jinshajiang suture zone; SDSZ, Shuanghu–Dingqing suture zone; BNSZ, Bangong–Nujiang suture zone; NGSZ, North Gangdese suture zone; YZSZ, Yarlung Zangbo suture zone, CMSZ: Changning-Menglian Suture Zone. New ages from suture zones: O1, this study; O2, Mo et al. (2008); O3, Li et al. (2008); O4, O5, Jian et al. (2009b); O6, Chen et al. (2001). New U–Pb data from eclogite and granite: E1, Pullen et al. (2008); E2, Yang et al. (2009); G, Zhu et al. (2009a). B: Schematic tectonic map of southern Tibet showing the sample location based on Pan et al. (2004) and Ding et al. (2005). Major faults: GCT, Great Counter thrust; ZGT: Zhongba–Gyangze thrust.

2. Geologic setting and gabbro samples

2.1. Geologic setting

The Tibetan Plateau is an amalgamation of several terranes namely Qaidam–Kunlun, Songpan–Ganzi–Hoh Xil, Eastern Qiangtang, Western Qiangtang and Lhasa, which are bounded by suture zones called A'nemaqin–Kunlun, Jinshajiang, Bangong–Nujiang, Shuanghu–Dingqing, and Yarlung Zangbo (Fig. 1A; Yin and Harrison, 2000; Zhang and Tang, 2009). These suture zones contain fragments of ocean basins pre-existing before the suturing of different terranes. The A'nemaqin–Kunlun Suture Zone (AKSZ), the Jinshajiang Suture Zone (JSZ), and the Shuanghu–Dingqing Suture Zone (SDSZ) are believed to be derived from the closing of the Paleo-Tethys, whereas the Bangong–Nujiang Suture Zone (BNSZ) is connected to the Meso-Tethys (Chen et al., 2001; Metcalfe, 2002, 2006; Pullen et al., 2008; Jian et al., 2008, 2009a, b). The southernmost YZSZ is widely accepted as the youngest suture that represents the southward obducted remnants of the

Table 1
Summary of ages from the YZSZ ophiolites.

Locality	Rock type	Methods	Age	References
Nangxian	Gabbro	Zircon U–Pb	191.4 ± 3.7 Ma	Zhang et al. (2009)
	Gabbro	Zircon U–Pb	147.2 ± 3.4 Ma	
	Basalt	Zircon U–Pb	145.7 ± 2.5 Ma	
	Basalt	Zircon U–Pb	147.8 ± 3.3 Ma	
Luobusa	Gabbro-diabase	Bulk-rock Sm–Nd	177 ± 33 Ma	Zhou et al. (2002)
	Diabase	Zircon U–Pb	162.9 ± 2.8 Ma	Zhong et al. (2006)
Zedong	Andesite dykes	Hornblende ^{40}Ar–^{39}Ar	156 ± 0.3 Ma	McDermid et al. (2002)
	Basalt	Bulk-rock Sm–Nd	175 ± 20 Ma	Wei et al. (2006a)
Dazhuqu	Radiolarian fauna	Radiolarian age	~130–112 Ma	Ziabrev et al. (2003)
Xigaze	Amphibolite sole	Hornblende ^{40}Ar–^{39}Ar	~127.7 ± 2.2 Ma	Guilmette et al. (2009)
Jiding	Gabbro	Zircon U–Pb	128 ± 2 Ma	Wang et al. (2006)
Sangsang	Diabase	Zircon U–Pb	125.2 ± 3.4 Ma	Xia et al. (2008a)
Xiugugabu	Diabase	Zircon U–Pb	122.3 ± 2.4 Ma	Wei et al. (2006b)
Yungbwa	Tholeiitic basalt	Bulk-rock Sm–Nd	147 ± 25 Ma	Miller et al. (2003)
	Tholeiitic basaltic dike	Hornblende ^{40}Ar–^{39}Ar	152 ± 33 Ma	