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An early Jurassic dextral strike-slip system in southern South China and its tectonic significance

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ABSTRACT

Ductile shear structure of the Guanging-Bobai fault belt in the SW part of the Qin-Hang belt, South China, has been investigated and interpreted in terms of radiometric dating data. A series of ductile shear zones occurs within the fault belt with deformation and metamorphic features indicative of formation under medium temperature and pressure conditions. The foliation such formed is steeply dipping and bears a gently plunging lineation, which along with the dextral kinematic indicators determines a broad NE-SW-trending dextral strike-slip regime responsible for the development of these shear zones. Field overprinting relationships indicate that this dextral shear is pre-dated by the Indosinian (P_2-T) NNE-verging thrusting and post-dated by the Yanshanian (J_2-K_2) SE-verging thrusting, and thus occurred during a transitional period between the two orogenies. ^{40}Ar–^{39}Ar radiometric dating on muscovite from mylonites further constrains timing of the dextral shear to the Early Jurassic (187–193 Ma). Based on the coeval tectonic framework of eastern Asia, we propose here that the dextral strike-slip system was initiated by the far-field oblique stress field from the incipient subduction of the Izanagi oceanic plate. An offset continental margin of the South China plate may have been created in response to this transcurrent movement along the fault belt, dissecting and displacing not only a relict Caledonian foreland basin, but also an Indosinian magmatic belt.

1. Introduction

The tectonic evolution of the South China plate from the Late Permian through the Mesozoic has been continually disputed in terms of plate tectonics and associated tectonic regime (e.g., Hsu et al., 1990; Wang and Lu, 1997; Zhou et al., 2006; Li and Li, 2007; Wang et al., 2007). In this regard, there are two broad episodes of tectonics that are relatively well studied at least with some consensus among majority of authors. The early one is called the Indosinian (P_2-T) orogeny that is characterized by a series of WNW-ESE trending folds and thrusts in the southern part of the plate resulting from collision from the Indochina plate in the Late Permian to Late Triassic time (e.g., Roger et al., 2000; Maluski et al., 2001; Lv et al., 2003; Lin et al., 2008; Zhang et al., 2009; Lepvrier et al., 2011). This event is followed by the Yanshanian (J_2-K_2) orogeny derived from the subduction of the Izanagi plate, a precursor of the Pacific plate, since the Middle Jurassic, leading to the development of an immense southeastern South China orogen (e.g., Chen et al., 1991; Li et al., 2001; Yan et al., 2003; Zhou et al., 2006; Lin et al., 2008). Comparably, however, there is little known about tectonism during the Early Jurassic transitional gap between the two orogenies.

A magmatic and tectonic quiescence has been generally proposed for this Early Jurassic time based on the statistic work on the Mesozoic granitoids distributed over southeastern South China (Zhou et al., 2006). This generality may be rather underrepresented due to recent evidence showing that extensive rift activity may have characterized this time of South China, resulting in a series of deep-sea basins filled with huge volumes of terrigenous clastic rocks, and sporadic magmatism with A-type geochemical nature (Li and Li, 2007; Zhu et al., 2010; Yu et al., 2010). Nevertheless, the associated specific tectonic regime and plate setting remain poorly constrained so far.

This paper documents a NE-SW trending strike-slip fault system, called the Guangning-Bobai shear belt, in southern South China that contains a series of ductile shear zones presenting a dextral kinematics and an early Jurassic age. Insights from this dextral shear system, therefore, may significantly improve our understanding of the geological dynamics of the South China plate in this Early Jurassic time. All field structural and kinematic data supporting this paper were gathered from ten traverses across the Guangning-Bobai fault belt and from the work along strike of major shear zones within the fault belt. Foliation and lineation were measured on foliated rock surfaces and plotted in stererographs by Wulff

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lower-hemisphere projection. Investigation of kinematic indicators either macroscopic or microscopic was conducted on the sections perpendicular to foliation and parallel to lineation. For constraining the age of ductile shearing, ^{40}Ar–^{39}Ar radiometric dating is included with discussion of ages available from the literature most published in Chinese. All localities cited in the text are noted in Fig. 2 or Fig. 6.

2. Geological framework of the South China plate

2.1. General tectonics

The South China plate is located in the southeastern part of the Eurasian continent (Fig. 1A), bounded to the north by the Qinling-Dabie-Sulu orogen (Yin, 1993), and to the southwest by Ailaoshan-Jinshajiang (Wang et al., 2000), Song Ma (Lepvrier et al., 2004; Trung et al., 2006), Babu-Phu Ngu (Wu et al., 1999), and Bangxi-Tunchang (Zhou et al., 1999; Li et al., 2002) sutures (Fig. 1B). Its west may extend into the Songpan-Ganzi basin (Chang, 2000), south submerges beneath the South China Sea (Hayes and Nissen, 2005), and east is being subducted in the Ryukyu island arc by the Pacific oceanic plate (Maruyama et al., 1997). The plate itself comprises two blocks, Cathysia and Yangtze, welded along the Jiangnan orogen (Huang, 1978; Zhang et al., 1984; Charvet et al., 1996) or the Nanhua rift area (Oh, 2006). The NE-SW-trending Qin-Hang belt was commonly portrayed as the suture between the two blocks (e.g., Chen, 1999; Gilder et al., 1996; Yan et al., 2003; Zhou et al., 2006), along which Precambrain ophiolites have been reported from the Jiang-Shao segment (Zhou, 1989; Chen et al., 1991; Li et al., 1997) and sporadic equivalent mafic or ultramafic assemblages have also been found in the Guanging-Bobai segment (Qin et al., 2005; Peng et al., 2006a). The northeastern extension of this tectonic belt was correlated with the Ogcheon belt in the Korea peninsular (Fig. 1A) (e.g., Oh, 2006).

A broad NE-SW-trending lineament characterizes the South China plate (Fig. 1B). However, in detail, there is a major change in tectonic patterns across the Qin-Hang belt, such that thrust and fold structures to the southeast and northwest of the belt show SE and NW vergence, respectively, whereas those in the interior of the belt present nearly vertical deformation (Chen, 1999; Li et al., 2001; Yan et al., 2003). In contrast, many WNW-ESE-trending thrusts or folds verging NNE are exposed in the southern part of the South China plate (Fig. 1B), such as in the regions of the Kangdian massif, the Nanpanjiang basin (cf. Wu et al., 1999; Liu et al., 2002; Peters et al., 2007), the Yunkai massif (Lin et al., 2008) and the northern Vietnam terrane (Roger et al., 2000; Maluski et al., 2001; Lepvrier et al., 2011).

2.2. Tectonic evolution

Since its assembly through the collision between the Yangtze and Cathysia blocks in the Neoproterozoic, the preserved geological record indicates that the South China plate has experienced at least three major episodes of tectonic disturbances in the Phanerozoic times (Huang, 1978; Zhang et al., 1984; Yang et al., 1986; Ren and Chen, 1989). The recognized earliest event is called Caledonian orogeny marked by an unconformity between the Lower Devonian and older formations over much of the South China plate (Guo et al., 1989; Ren and Chen, 1989). The exceptions do exist mainly along what are now its marginal areas, such as in the Qinzhou belt (Fig. 1B) where deep-water deposition continued throughout the Paleozoic (GXBGM, 1985; GDBGM, 1988). Exposures of granitoids emplaced during this period are sporadically distributed within this plate. Subsequent geology of the South China plate was ruled by a relatively stable, epeiric sea platform with deposition of a huge sheet of shallow-water carbonates until the arrival of the Indosinian orogeny (Enos et al., 1998).

This resurgent orogenesis (P_2-T) was involved in the building of Southeast Asian part of the Pangea supercontinent from the Late Permian through Triassic by amalgamation of several continental masses, such as North China, South China, Indochina, Sibumasu, and North Qiangtang (Sengor et al., 1988; Hutchison, 1989, 1993). This broad event concluded with a regional unconformity between the latest Triassic and older formations, and also led to a series of NNE-verging thrusting structures as in the southern part of the South China plate (e.g., Wu et al., 1999; Lin et al., 2008; Lepvrier et al., 2011). Coeval magmatism was dispersed in the interior of the plate, while most voluminous production was concentrated in the boundary areas with other plates, such as in the Qinling-Dabie orogen (Williams et al., 2009; Jiang et al., 2010; Qin et al., 2010; Zhao et al., 2011), the Songpan-Ganzi basin (Roger et al., 2004; Xiao et al., 2007; Zhang et al., 2006) and its southern margin (Chen et al., 2011; GXBGM, 1985; Tran Trong Hoa et al., 2008; Li et al., 2006).

Significant marine deposition, mainly as terrigenous clastic rocks, still prevailed in the latest Triassic to Early Jurassic time (e.g., Li and Li, 2007), but after that, the plate was entirely uplifted following the Yanshanian orogeny (J_2-K_2). This tectonic event is typically attributed to the NW-directed subduction of the precursors of the Pacific plate beneath the eastern margin of the South China plate in the Middle Jurassic to Late Cretaceous time (e.g., Zhou et al., 2006). The resulting tectonics is manifested in the marvelous 1300 km wide southeastern South China orogen, comprising a broad series of NE-SW-trending folds, thrust faults and intramontane basins (Chen, 1999; Yan et al., 2003; Li and Li, 2007) (Fig. 1B). The same NE-SW lineaments also controlled the coeval widespread emplacement of arc-related magma with presently exposed outcrops accounting for more than one quarter of the continental area of southeastern South China (Zhou et al., 2006).

Several less significant tectonic events have also partly impacted the South China plate since the Late Cretaceous, such as those related to obduction of the Philippine oceanic plate (Lee and Lawver, 1995; Sibuet and Hsu, 1997), opening of the South China Sea (Yao, 1999; Li et al., 2005b; Shi et al., 2011) and uplifting of the Tibet plateau (Tapponnier et al., 1990). These events have only localized effects, in particular notable on its southern margin. There, extensive rifting accompanied by strong basalt eruption has occurred perhaps during the extension related to the opening of the South China Sea from the Late Cretaceous to Miocene (e.g., Zhou et al., 1995; Hayes and Nissen, 2005).

3. General outline of the Guangning-Bobai shear belt

3.1. Tectonic units containing the shear belt

The Guangning-Bobai shear faulting belt lies in the southwestern part of the Qin-Hang tectonic belt (Fig. 1B), where it traverses through several tectonic units or the boundary between them. In the north, the shear belt cuts through the eastern side of the Dayaoshan uplift (Fig. 2), a broad WNW-ESE trending anticlinorium formed during the Indosinian orogeny that comprises the Cambrian formations in the core and Late Paleozoic formations on the flanks (GXBGM, 1985). Further to the north, it may join the NNE-trending Xiang-Gan part of the Qin-Hang belt with uncertain kinematics (Fig. 1B). Southwardly, the shear belt extends along the NE-SW-trending boundary between the Qinzhou belt and the Yunkai massif (Fig. 2) into the Beibu gulf (Fig. 1B), where it may joint the three-juncture-rift system consisting of the Red River, Beibu gulf and yinggehai basin fault zones (Rangin et al., 1995; Zhu et al., 2009). The Qinzhou belt, also called the Qinfang sea trough, is characterized by the development of a continuous succession of