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A new model for the Indochina and South China collision during the Late Permian to the Middle Triassic

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ABSTRACT

A comparative analysis of Indochina and South China during the Early Paleozoic indicates the former may be extended to include North Vietnam, part of the Qinzhou tectonic zone and southern Hainan Island. These three regions were traditionally regarded as parts of South China separated from Indochina by the Song Ma suture in Central-North Vietnam. A new suture, called the Dian-Qiong suture, is proposed here, approximately along the southern margin of the present Nanpanjiang basin. This suture is linked to its eastern counterpart in Hainan Island through a NNE-trending dextral transform fault zone along the eastern margin of the Nanpanjiang basin. The conventional Song Ma suture originally constitutes its western extension and was translated to its present location by sinistral displacement along the Red River Fault Zone during the Tertiary. Upper Paleozoic deep-water turbidites and associated mid-oceanic ridge basalts along the suture in the Nanpanjiang basin illustrate a coeval ocean between Indochina and South China. The ocean was consumed by south-directed subduction beneath Indochina during the Late Permian to the Middle Triassic. This suture zone was finally re-shaped by the indentation between the active margin of Indochina and the irregular passive continental margin of South China during the Late Triassic as well as displacement along the Red River fault zone during the Cenozoic.

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1. Introduction

Southeastern Asia comprises an assemblage of allochthonous continental blocks delineated by a series of Tethyan sutures (Fig. 1A). These blocks are usually believed to have originally rifted from Gondwana during the Paleozoic, subsequently drifted across the Tethys and finally accreted to Eurasia during the Mesozoic. However, there are many disputes regarding their collisional time, original location and relationships to each other. This is particularly true for Indochina and South China. Several collisional models have been proposed for these two blocks. For example, the collision has been proposed to have terminated in North Vietnam along the Song Ma suture during the Silurian (Carter et al., 2001; Carter and Clift, 2008) or the Devonian to Early Carboniferous times (Gatinsky, 1986; Gatinsky and Hutchison, 1987; Hutchison, 1989a,b), or along the Song Da suture during the Late Triassic (Sengör, 1984) (Fig. 1B). Furthermore, the subduction polarity is still disputed to be SW-dipping (Lan et al., 2000, 2003) or NE-dipping (Lepvrier et al., 2004), although increasing structural and geochronological evidence across Vietnam tends to support a major collisional event occurring along the Song Ma suture in the Late Permian-Early Triassic.

These interpretations provide a great challenge to understanding the Indosinian orogeny, a term usually used to describe the Triassic mountain-building events across southeastern Asia (for review see Carter and Clift, 2008 and references therein). Clearly, an elucidation of the Indochina-South China collision is critical to deciphering the evolution of Eurasia and the Tethys. However, these proposed models have important weaknesses: (1) there have so far been no reports regarding the age of the ophiolite along the Song Ma or Song Da zones (see Lepvrier et al., 2004 for details); (2) these models were based overwhelmingly on paleontological and paleomagnetic data. However, the similar paleontological provinciality (Metcalfe, 2002) and paleomagnetic record (Li et al., 2004) of the two blocks make it impossible to distinguish their separation and/or amalgamation times, as well as their boundary; (3) previous work has been focused more commonly on the Vietnamese territory and the geological data from China have not scientifically been incorporated into the interpretation. New comprehensive studies are essential to unravel the puzzles regarding the Indochina-South China collisional tectonic evolution.

Mafic or ultramafic rocks associated with Upper Paleozoic deep-water sediments have recently been widely reported in Chinese literature along the China–Vietnam border in Chinese side (Wu et al., 1993, 1994; Wang, 1994; Zhang et al., 1995; Wang et al., 1995, 1997;

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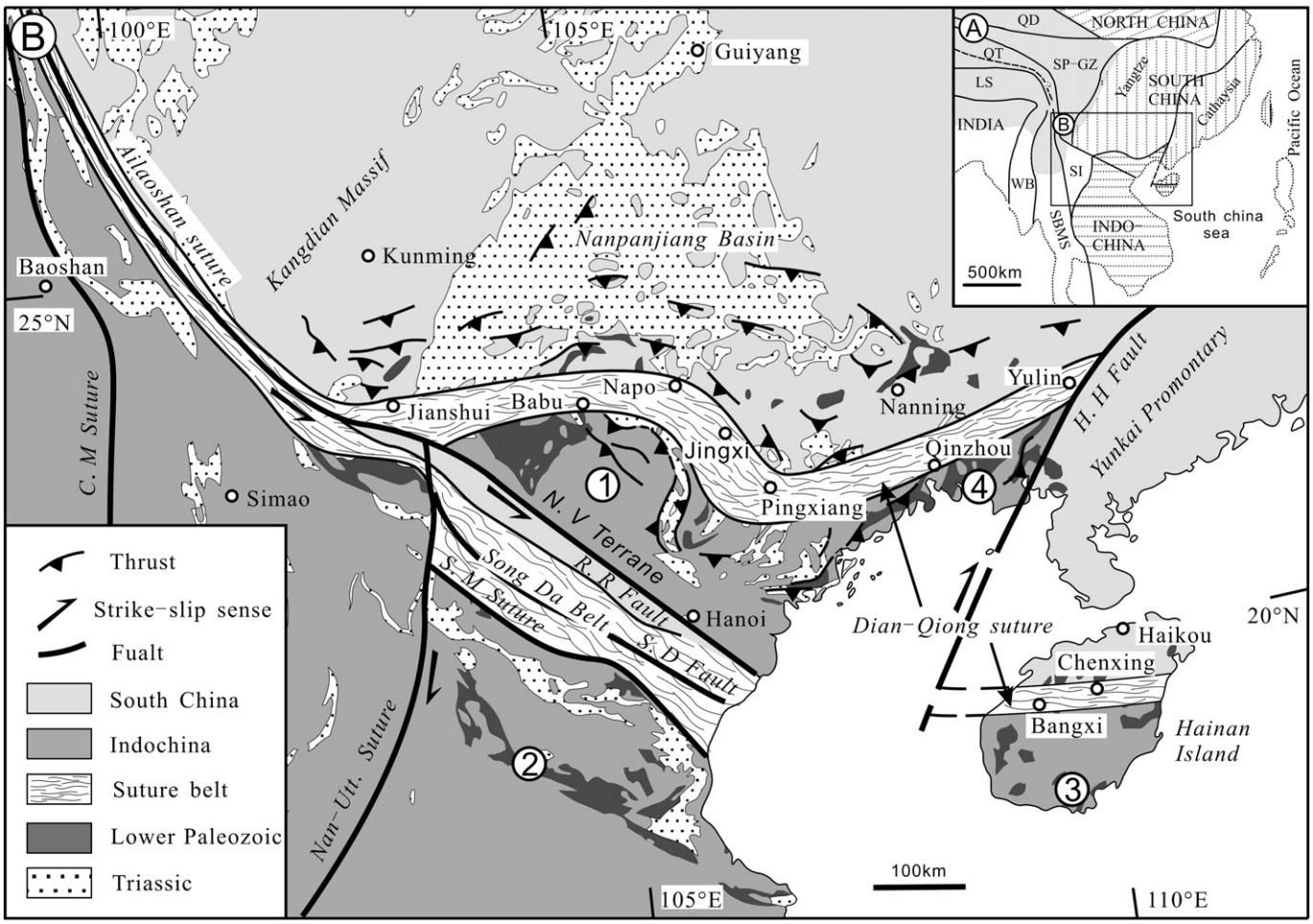

Fig. 1. (A) Sketch of tectonic map of southeastern Asia, simplified after K. Zhang et al. (2006). Abbreviations: LS, Lhasa; QD, Qaidam; QT, Qiangtang; SBMS, Sibumasu; SI, Simao; SM, Song Ma; SP-GZ, Songpan-Ganzi; WB, West Burma. (B) Sketch structural map of the adjacent region between South China, Indochina, Simao and Sibumasu, showing the main tectonic units and sutures. Note that partial area south immediate to the Red River Fault Zone should belong to South China according to Lan et al. (2001) and C. Wang et al. (2007). Numbers show locations of stratigraphical columns in Fig. 2. Abbreviations: C.M. Suture, Chiang Mai Suture; H.H. Fault, Hepu-Hetai Fault; N.V. Terrane, North Vietnam Terrane; R.R. Fault, Red River Fault; S.D. Fault, Song Da Fault; S.M. Suture, Song Ma Suture.

Ma, 1998; Zhong et al., 1998; Dong and Zhu, 1999; Wu et al., 2000, 2001, 2002; Zhang et al., 2003) (Fig. 1B). Most of these mafic rocks have been diagnosed as having mid-oceanic ridge characteristics (Zhong et al., 1998; Ma, 1998; Wu et al., 2002). This suggests an ocean between North Vietnam and South China during the Late Paleozoic. Thus, the tectonic boundary between Indochina and South China could be located north of the North Vietnam block (Fig. 1B). Here, we present new data about stratigraphy, paleontology, magmatism and geochronology across the areas between these two continental blocks. A new model is then proposed for the Triassic collision between Indochina and South China along the reappraised plate boundary.

2. Tectonic framework of southeastern Asia

Continental lithospheric blocks now composing southeastern Asia mainly include South China (Yangtze and Cathaysia), Indochina, Simao, Sibumasu and West Burma (Metcalfe, 2002) (Fig. 1A). These blocks are separated by narrow sutures, in which dismembered ophiolites or deep-sea sediments were discovered, possibly representing remnants of different Tethyan basins (Hutchison, 1975, 1989b, 1993; Sengör, 1984). A main Paleotethyan suture was identified as the Lancangjiang or Changning-Menglian suture in southwestern China (Wu et al., 1995), the Chiang Mai and Sra Kaeo suture in Thailand (Hada et al., 1999), and the Bentong-Raub suture in Malaysia (Hutchison, 1975; Metcalfe, 2000). This suture separates blocks that were not attached to Gondwana until the earliest Permian to the west from those untied with Gondwana during the Mesopaleozoic to the east (in present position) (e.g., Metcalfe, 1999; Lepvrier et al., 2004).

Sibumasu and West Burma lie west of the main Paleotethyan suture (Fig. 1A). West Burma is separated from Sibumasu by a Meso-Tethys suture stretching along the Shan Boundary Fault, the Andaman sea basin and the Woyla Suture in Sumatra (Barber, 2000). Together with Lhasa, it was interpreted to have rifted from Gondwana during the Late Triassic and to have accreted to Sibumasu during the Late Jurassic or Early Cretaceous (Gaetani and Garzanti, 1991; Yin and Harrison, 2000; Li et al., 2004). Sibumasu, the eastern part of the Cimmerian continent of Sengör (1979, 1984), is located between the sutures representing the Mesotethys to the west and the Paleotethys to the east. Its Gondwana affinity continued until the Sakmarian based on glacio-sea diamictites and cold-water faunas and floras (Metcalfe, 2002) and then shifted into Cathaysian province during the Late Permian (Shi et al., 1995; Shen et al., 2002). Magmatism, stratigraphy and paleomagnetic data all indicate Late Permian to Middle Triassic suturing with the blocks lying east of the main Paleotethyan suture (Carter et al., 2001; Li et al., 2004; Carter and Clift, 2008).

East of the main Paleotethyan suture are South China, Simao and Indochina (Fig. 1A), which are together characterized by a similar paleontological evolution during the whole Phanerozoic. Among these, the Yangtze and Cathaysia blocks have generally been thought of as an entity (South China) during the Precambrian based on Proterozoic

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