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Terrestrial Permian–Triassic boundary in southern China: New stratigraphic, structural and palaeoenvironment considerations

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ABSTRACT

The Permian–Triassic boundary is located above the main Phanerozoic terrestrial and marine biotic crisis. Southwest China (eastern Yunnan and western Guizhou) is considered as an ideal place in Asia to study the terrestrial Permian–Triassic boundary, its correlation with the stratigraphically equivalent marine deposits, and to discuss the contemporaneity between the marine and terrestrial extinctions. The Chahe and Zhejue sections, which have already been studied in detail, especially using $\delta^{13}C$ isotopic analyses for both sections and geochronology for the Chahe section, are considered to be the reference terrestrial sections to discuss changes (both through time and space) in macroflora, pollen diversity and paleoenvironment. Based on new structural analyses of these sections, we demonstrate that they have been strongly affected by polyphase deformations and are, therefore, not suitable to discuss the vertical and/or lateral evolutions of the depositional environments within the Permian–Triassic succession. The use of the Chahe and Zhejue sections to study the contemporaneity between marine and terrestrial extinction events at the end of the Permian in southern China, as well as the stratigraphic correlations and the palaeoenvironment reconstitution of western Guizhou and eastern Yunnan, therefore, must be reconsidered.

1. Introduction

South China is known for its well-preserved marine Permian–Triassic boundary (PTB) sections, especially that of Meishan in Zhejiang Province (Fig. 1) (e.g. Yin et al., 2001). Additionally, southwest China (eastern Yunnan and western Guizhou) is also considered as an ideal place to investigate the terrestrial Permian–Triassic boundary (Peng et al., 2005, 2006; Zhang et al., 2006; Yu et al., 2007, 2010; Shen et al., 2011; Vajda and Bercovici, 2014; Bercovici et al., 2015; Zhang et al., 2016), to study the transition from terrestrial to marine facies, and to provide correlations with the Meishan marine section across the Yangtze Platform (Shen et al., 2011; Glen et al., 2009; Peng and Shi, 2009; Wang et al., 2011; Yu et al., 2015; Cui et al., 2016). Among several sections, the terrestrial Chahe and Zhejue sections, located to the south of the Sichuan Basin (Figs. 1 and 2A), are considered as classical sections, especially the Chahe section which is proposed as an equivalent of the Meishan PTB GSSP (Global Stratotype Section and Point). However, both sections are situated in a region strongly deformed during Mesozoic and Cenozoic tectonic events (e.g. Liu et al., 2012; Wang et al., 2013). The effects of deformation are rarely taken into consideration when studying the PTB and the sections are usually described as continuous through the Paleozoic–Mesozoic boundary (e.g. Peng et al., 2006; Yu et al., 2007; Bercovici et al., 2015). Here we present the first detailed structural analysis for these two classical sections and we show that deformation affected their stratigraphic continuity. These data allow us to discuss the validity of the supposed position of the PTB in this area and its possible correlation with the marine Meishan PTB GSSP.

2. Geological setting

The Permian-Triassic sections classically studied in western Guizhou and eastern Yunnan are located along the northern edge of the Nanpanjiang Basin (Fig. 1), within an area characterized by large NE–SW trending folds and thrust structures affecting both the Proterozoic substratum and the Paleozoic–Mesozoic sedimentary cover (Fig. 2A). To the NE, this deformation correlates with the Mesozoic Daloushan and Xuefeng tectonic belts (e.g. Liu et al., 2012; Deng et al., 2015; Faure et al., 2016) across the major NW–SE trending, left-lateral Ziyun–Luodian fault (Figs. 1, 3A, B). This Paleozoic inherited fault that

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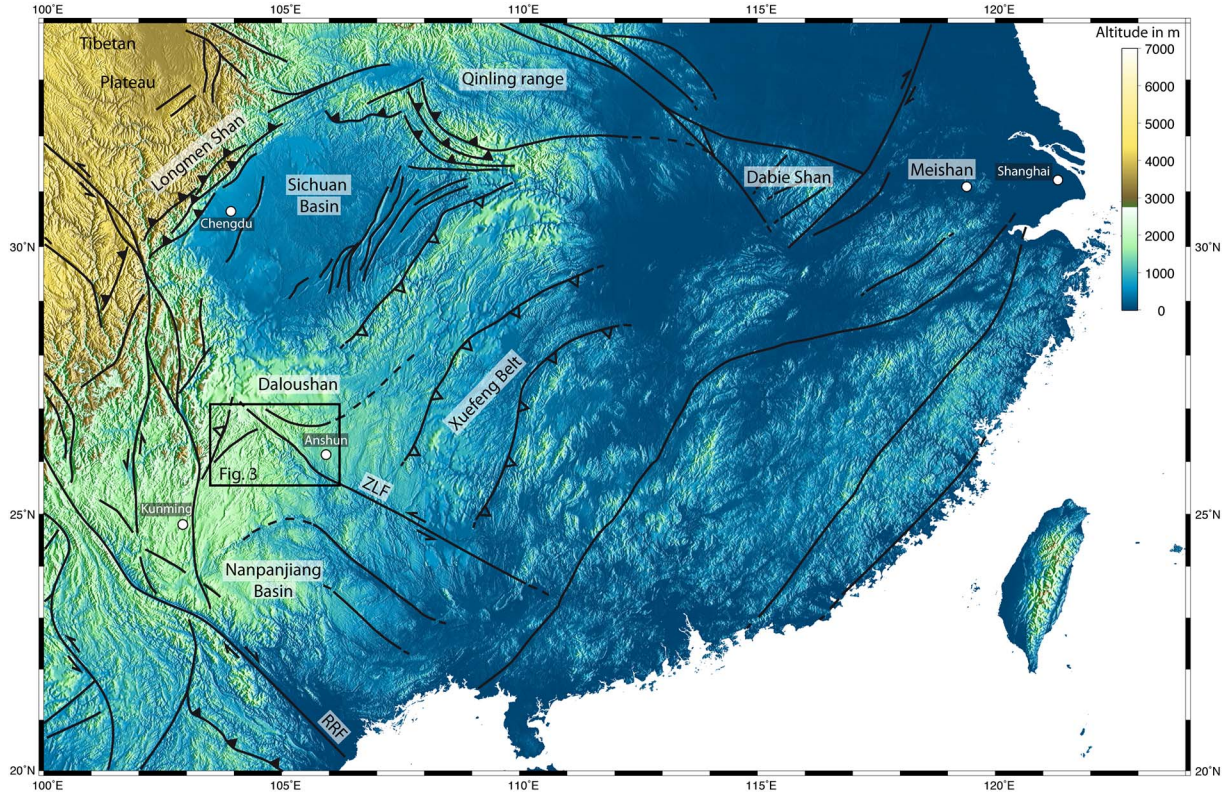

Fig. 1. Topographic map of SE China showing the location of the studied area as well as the main tectonic structures. Faults with plain black triangles are Cenozoic active thrusts, opened black triangles indicate Mesozoic thrusts. ZLF: Ziyun–Luodian fault; RRF: Red River fault.

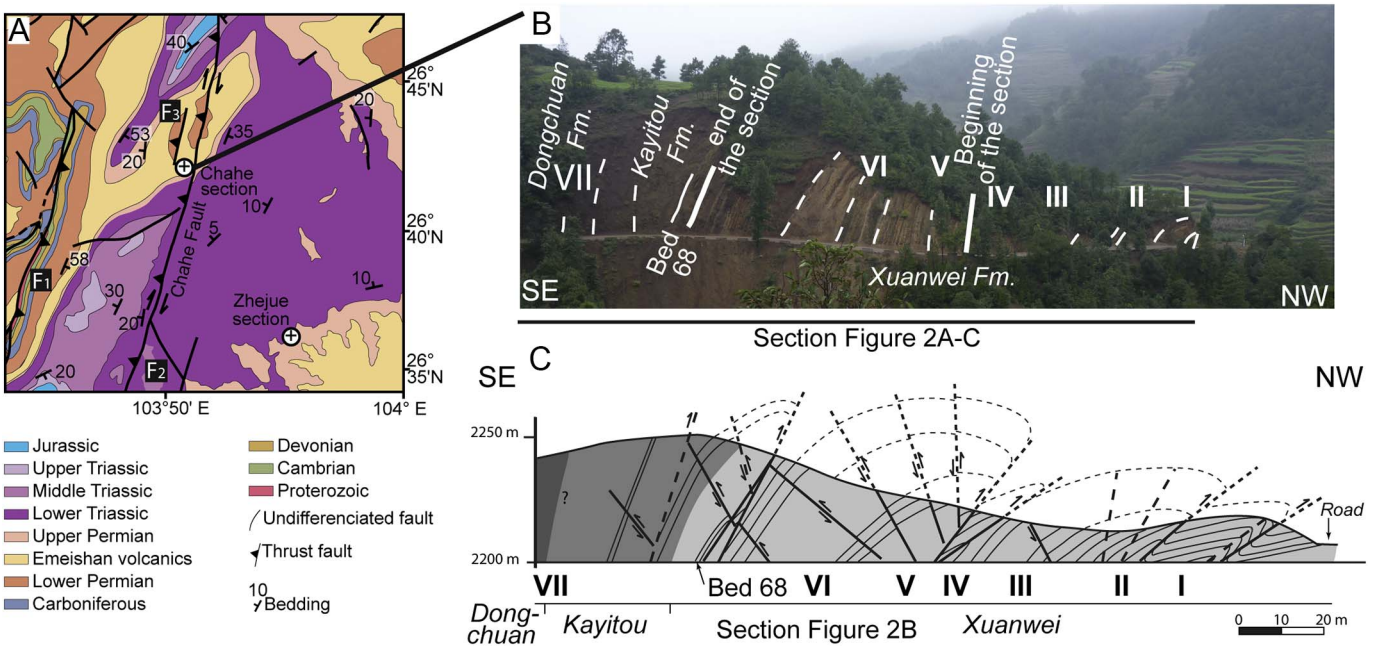

Fig. 2. A: Geological map of the studied area simplified from the Bureau of Geology and Mineral Resources of Guizhou Province (1980). See location on Fig. 3B; B: General view of the Chahe outcrop; C: Interpreted geological section. Labels I to VII refer to the main features illustrated on pictures in Figs. 7, 8, 9 and 10. General bedding attitude is indicated by white dotted lines.

acted as a top-to-the-NNW thrust during the Triassic was reactivated as a normal fault during the Jurassic. From the Late Jurassic to the Aptian–Turonian, SE China was affected by a compressive regime associated with the Yanshanian orogeny and driven by the subduction of the Izanagi (Paleo-Pacific) oceanic plate along the eastern margin of Asia (e.g. Yan et al., 2003). Before reaching its zenith during the Late Cretaceous with the emplacement of arc-related magmas along the southeastern margin of China (e.g. Zhou et al., 2006), the Yanshanian orogeny resulted in the formation of a large NE–SW trending fold-and-thrust belt that extends north of the Triassic Nanpanjiang (or Youjiang) Basin up to the Qinling–Dabie orogen (Fig. 1) (e.g. Chen, 1999; Yan et al., 2003; Li and Li, 2007; Richardson et al., 2008). The major faults