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Climatic and tectonic controls on Late Triassic to Middle Jurassic sedimentation in northeastern Guangdong Province, South China

Chong-Jin Pang [a,b,*], Zheng-Xiang Li [b], Yi-Gang Xu [c], Shu-Nv Wen [a], Bryan Krapež [d]

[a] College of Earth Sciences, Guilin University of Technology, Guilin 541004, China
[b] The Institute for Geoscience Research (TIGeR), ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS), Department of Applied Geology, Curtin University, GPO Box U1987, Perth, WA 6845, Australia
[c] State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry Chinese Academy of Sciences, Guangzhou 510640, China
[d] Department of Applied Geology, Curtin University, GPO Box U1987, Perth, WA 6845, Australia

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ABSTRACT

Stratigraphic analyses document climatic and tectonic controls on the filling of a Late Triassic to early Middle Jurassic (T_3–J_2) basin that developed on top of a young orogenic belt in southeastern South China. About 2700 m of Carnian to Bajocian sedimentary rocks is documented in the Meizhou region, Guangdong Province. The Carnian to Rhaetian sequence is characterized by deltaic facies that are succeeded by Hettangian fluvial, shallow marine and volcaniclastic facies, and by Sinemurian to early Toarcian interdistributary bay and floodplain facies. The late Toarcian to Bajocian sequence comprises proximal alluvial to lacustrine facies that changed upwards to fluvial facies. Fossil assemblages indicate that climatic conditions changed from tropical/subtropical warm humid, to temperate humid, and then to hot arid through the Late Triassic to the Middle Jurassic. Climatically induced changes (e.g., in precipitation, vegetation and erosion) exerted a strong influence on sediment supply, whereas tectonics played a dominant role in stratigraphic evolution, accommodation generation, sedimentation pattern and volcanism. Tectonostratigraphic analysis shows that the T_3–J_2 basin was initiated on an orogenic belt during late-stage orogeny, and evolved into shallow-marine and volcanic environments and then back to terrestrial facies during the post-orogenic stage. This was followed by regional uplift and the development of a basin-and-range province. The order of these events is similar to that of the central Rocky Mountains, western North America during the Palaeogene. The Mesozoic basin of South China and the Eocene basins of the central Rocky Mountains highlight the importance of subduction-related subsidence above young and broad orogens.

1. Introduction

Shallow-marine platform carbonates and coal-bearing siliciclastic sedimentary sequences developed on the southeastern South China Block during the Late Palaeozoic (Liu and Xu, 1994; Wang, 1985). Those sequences were followed by a period of Late Permian to Early Mesozoic deformation, metamorphism and magmatism that is known as the Indosinian Orogeny (Cui and Li, 1983; Hsu et al., 1990; Li and Li, 2007; Li, 1998; Pang et al., 2014; Ren, 1984; Wang et al., 2005b; Wang et al., 2013; Zhou et al., 2006). Li and Li (2007) and Li et al. (2012) proposed that the Indosinian Orogeny initiated at ca. 280 Ma at the onset of subduction of the Palaeo-Pacific Ocean, proceeding into a period of flat-slab subduction during the ca. 250–190 Ma period. This resulted in the formation of a 1300 km-wide magmatic fold-thrust (i.e., orogenic) belt recording a northwestward younging of magmatism and deformation in southeastern South China. In contrast, Zhou et al. (2006) considered that 250–205 Ma granitoids in the region were generated by collision between the South China Block and the Indochina Block, followed at ca. 180 Ma by subduction of the Palaeo-Pacific Ocean. Nonetheless, orogenic movements were interpreted to have ended by ca. 195–190 Ma (Li and Li, 2007; Zhu et al., 2010).

A Late Triassic to Early Jurassic (T_3–J_1) basin formed on top of the Indosinian Orogen, evolving from terrestrial to shallow-marine and then back to terrestrial environments (Fig. 1A; Li and Li, 2007; Liu and Xu, 1994; Pang et al., 2014; Wang, 1985). The T_3–J_1 basin was interpreted to be a sag basin (Li and Li, 2007) or a post-orogenic basin developed during late stage Indosinian Orogeny (Shu et al., 2009). Deposition in the T_3–J_1 basin was followed by terrestrial fault-bounded red-bed sedimentation and extensive magmatism throughout eastern South China from the Middle Jurassic to the Cretaceous (Pang et al., 2014; Shu et al., 2004, 2009; Zhou and Li, 2000; Zhou et al., 2006), in what is commonly referred to as a basin-and-range type province (Gilder et al., 1991; Li and Li, 2007) or an intracontinental extensional basin (Shu et al., 2009). New field and geochronological investigations show that the Late Triassic to Early Jurassic deposits are conformably overlain by the early Middle Jurassic terrestrial succession (named the

* Corresponding author at: College of Earth Sciences, Guilin University of Technology, Guilin 541004, China.
E-mail address: chongjinpang@glut.edu.cn (C.-J. Pang).

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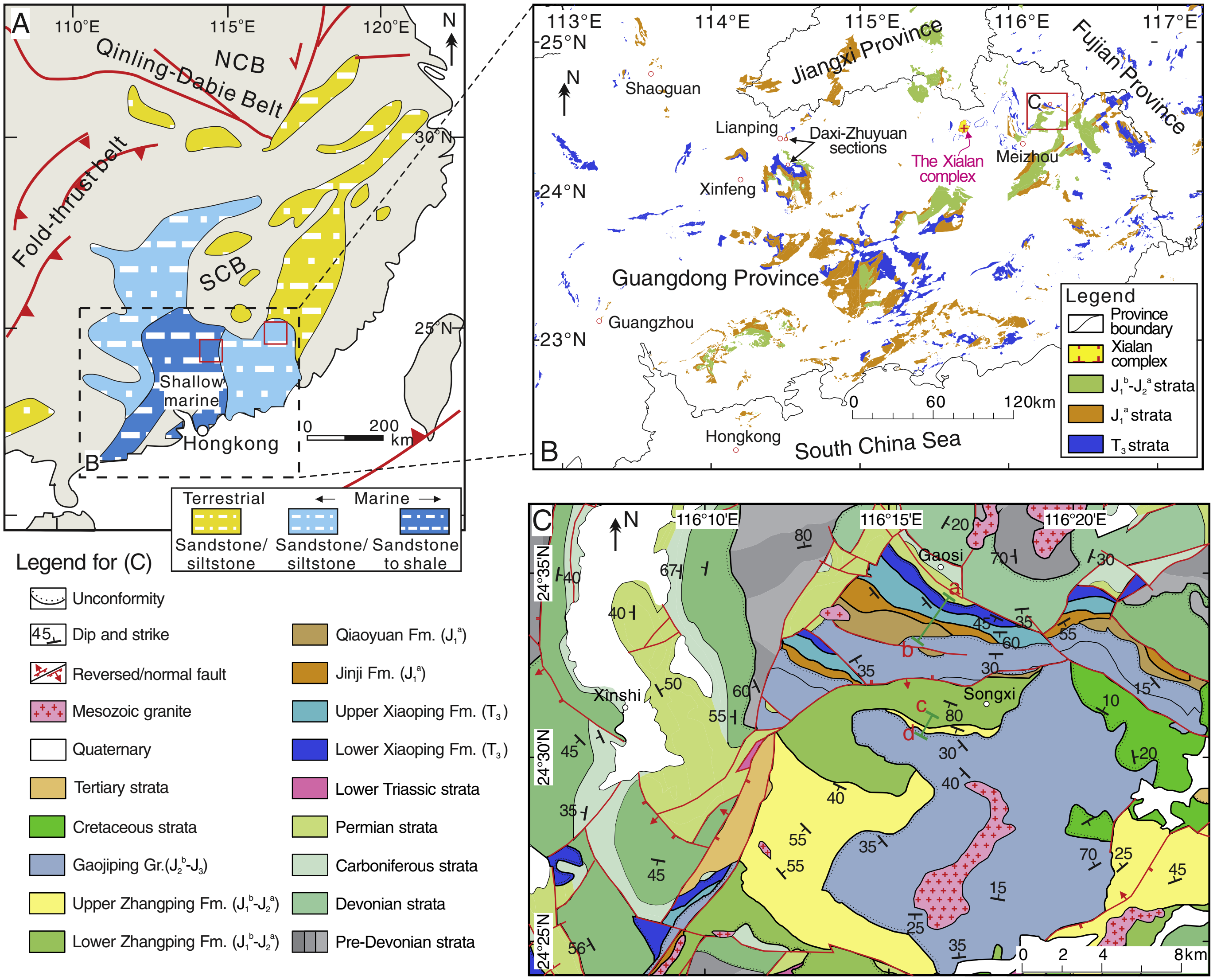

Fig. 1. Geological maps of the study area. (A) Palaeogeography of the Early Jurassic in southeast South China (modified after Li and Li, 2007). (B) Distribution of Upper Triassic to Middle Jurassic (T_3–J_2) strata in Guangdong Province. J_1^a represents early-Early Jurassic, J_1^b late-Early Jurassic, J_2^a early-Middle Jurassic. (C) Geological map of the Gaosi-Songxi area (modified after 1:200,000 scale geological map—Meixian Sheet (G-50-XXX III)). Measured sections marked by a–b and c–d. L = Lower; U = Upper; Fm. = Formation; Gr. = Group.

T_3–J_2 basin hereafter), which is overlain disconformably by late Middle Jurassic-Cretaceous strata in northeastern Guangdong Province (Figs. 1B–C and 2; GDBGMR, 1988, 1996; Guo et al., 2012; Pang et al., 2014; Shu et al., 2009). Therefore, the T_3–J_2 basin spans late-stage orogeny and post-orogenic extension (Pang et al., 2014), such that its stratigraphic architecture and history are key to an understanding of tectonic processes and basin evolution behind active convergent continental margins.

The Indosinian Orogeny records important climatic changes throughout southeastern South China. For instance, coal-bearing siliciclastic sequences of Late Permian age or of Late Triassic–Early Jurassic age are overlain by the Middle Jurassic to Cretaceous red-beds. Palaeontological and geochemical data indicate a climatic change from warm humid during the Late Triassic to hot arid during the Middle Jurassic-Cretaceous (Qian et al., 1987; Xiong et al., 2009; Xu et al., 2010, 2012). However, the role of such climatic change on depositional systems within the T_3–J_2 basin is poorly constrained.

Late Triassic to early Middle Jurassic (T_3–J_2) sedimentary rocks are widely distributed throughout southeastern South China, but are particularly well preserved and continuously exposed in the Gaosi-Songxi sections, Meizhou region, northeastern Guangdong Province (Fig. 1B–C), despite poor preservation in places due to weathering and vegetation cover. Therefore, the aims of this paper are to: (1) reconstruct the temporal and spatial evolution of depositional environments in southeastern South China; (2) evaluate the relative importance of climatic and tectonic controls on sedimentation; and (3) provide insights into the link between evolving palaeogeography and lithospheric processes. The work presented here builds on the field and laboratory studies reported in Pang (2014).

2. Geological setting and chronostratigraphy

The South China Block comprises the Yangtze Block to the northwest and the Cathaysia Block to the southeast. Collision between the two blocks during the Early Neoproterozoic (1200–880 Ma) produced the present-day South China Block (Li et al., 2002; Li et al., 2008). The studied section in Jiaoling County, Meizhou region, northeastern Guangdong Province is located in the south-central Cathaysia Block (Fig. 1B; GDBGMR, 1971). Upper Palaeozoic–Lower Mesozoic strata comprise Upper Devonian to Lower Carboniferous siliciclastic sedimentary rocks, Upper Carboniferous–Lower Permian carbonates, Middle to Upper Permian coal-bearing siliciclastic sedimentary rocks, and Lower Triassic carbonates and mudstones (Fig. 1C; GDBGMR, 1971, 1988), which are collectively defined as foreland deposits (Li and Li, 2007).