Cretaceous Research 57 (2016) 50–65

Contents lists available at ScienceDirect

Cretaceous Research

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

Cretaceous sedimentary basins in Sichuan, SW China: Restoration of tectonic and depositional environments

Yingqiang Li, Dengfa He*, Longbo Chen, Qinghua Mei, Chuanxin Li, Li Zhang

The Key Laboratory of Marine Reservoir Evolution and Hydrocarbon Accumulation Mechanism, The Ministry of Education, China University of Geosciences, Beijing 100083, China

ARTICLE INFO

Article history:
Received 5 June 2014
Received in revised form
10 July 2015
Accepted in revised form 21 July 2015
Available online 25 August 2015

Keywords:
Cretaceous sedimentary basins
Restoration
Sichuan Basin
Tectono–depositional environment
Temporal-spatial evolution

ABSTRACT

This study documents sediment infill features and their responses to the tectonic evolution of the Sichuan Basin and adjacent areas. The data include a comparison of field outcrops, well drillings, inter-well correlations, seismic data, isopach maps, and the spatial evolution of sedimentary facies. We divided the evolutionary history of the Sichuan Cretaceous Basin into three stages based on the following tectonic subsidence curves: the early Early Cretaceous (145–125 Ma), late Early Cretaceous to early Late Cretaceous (125–89.8 Ma), and late Late Cretaceous (89.8–66 Ma). The basin underwent NW–SE compression with northwestward shortening in the early Early Cretaceous and was dominated by alluvial fans and fluviolacustrine sedimentary systems. The central and northern areas of the Sichuan Basin were rapidly uplifted during the late Early Cretaceous to early Late Cretaceous with southwestward tilting, which resulted in the formation of a depression, exhibited southwestward compression, and was characterized by aeolian desert and fluviolacustrine deposits. The tectonic framework is controlled by the inherited basement structure and the formation of NE mountains, which not only affected the clastic supply of the sedimentary basin but also blocked warm-wet currents from the southeast, which changed the climatic conditions in the late Late Cretaceous. The formation and evolution of Cretaceous sedimentary basins are closely related to synchronous subtle far-field tectonism and changes in climate and drainage systems. According to the analysis of the migration of the Cretaceous sedimentation centers, different basin structures formed during different periods, including periods of peripheral mountain asynchronous thrusting and regional differential uplift. Thus, the Sichuan Cretaceous sedimentary basin is recognized as a superimposed foreland basin.

1. Introduction

The Cretaceous period is recognized as a key transitional period of plate tectonic evolution in China and adjacent areas and as a significant period during the Mesozoic intracontinental orogeny of South China (Wu, 2006; Li, Zhang, Dong, & Li, 2012a; Li, Zhang, Dong, Johnston, 2014), during which large-scale taphrogenic and magmatic activity occurred that generated the large "South China Extensional Basin and Igneous Province" (Zhou, Sun, Shen, Shu, & Niu, 2006; Shu et al., 2009; Li, et al., 2014). This transition was mainly manifested by the transition from north–south divergence to east–west divergence during the Cretaceous (Wu, 2006). Neogenic structures played a dominant role in the eastern region of South China, and tectonic inheritance played a dominant role in the west (Li, 1996; Wu, 2006). Previous research studies regarding Cretaceous tectonics in South China have focused on the eastern region of South China (e.g., Shen et al., 2012; Hu et al., 2012; Wang, 2013; Wang, et al., 2013a; Li et al., 2012a; 2014). However, due to severe destruction, geologists have not considered complex tectonic evolution, wide deposition with subsequent erosion, or poor oil-gas accumulation conditions in the western region of South China as priorities.

The Sichuan Basin is located in the western area of the South China Block and represents this region. Reconstruction of the Sichuan Cretaceous sedimentary basins, which are related to the Mesozoic intracontinental orogeny, can provide significant clues to help reveal the Cretaceous temporal-spatial evolution of the tectono-depositional environment in the western part of the South China Block. Regional uplift following the Cretaceous converted the

* Corresponding author.
E-mail addresses: yingqiangcugb@126.com (Y. Li), hedengfa282@263.net (D. He).

http://dx.doi.org/10.1016/j.cretres.2015.07.013
0195-6671/

eastern part of the Upper Yangtze into an erosional area (e.g., Yuan et al., 2010; Tang, Yan, Qiu, Gao, & Wang, 2013; Li & Shan, 2011). Currently, residual Cretaceous rocks only exist in the southern, western, and northwestern Sichuan Basin, which are characterized by "gray beds" in the north and "red beds" in the south. Although many researchers agree that the Sichuan Basin entered a shrinking and decline stage at the beginning of the Cretaceous period, most previous studies that have focused on lithofacies paleogeography, paleostructure, paleoclimate, paleoenvironment, or sedimentary basin properties have focused on the present-day residual basin (e.g., Chen, 1987; Guo, Deng, & Han, 1996; Meng, Wang, & Hu, 2005; Long, Chen, Lin, Xu, & Cheng, 2011; Geng, 2011). However, no integrated studies have combined tectonics and sedimentology, and systematic and dynamic research is lacking. Consequently, the following questions must be answered: Did the Cretaceous hiatus in the eastern Sichuan Basin result from a lack of deposition in the late depositional period or from complete erosion during the uplift period? How large was the Sichuan Basin in the Cretaceous? What was the tectonic and depositional environment?

To answer these questions, our study attempts to reconstruct Sichuan Cretaceous sedimentary basins by interactively synthesizing available data. The data sets used in this study include comparisons of abundant field outcrops, well drillings, inter-well correlations, seismic data, isopach maps, and the spatial evolution of sedimentary facies. Although preliminary in nature, our study aims to provide a starting point for more comprehensive future studies.

2. Geological setting

2.1. Tectonic setting of the Sichuan Basin

The Sichuan Basin is located in central–southern Asia, in central China, and in the western area of the South China Block (Fig. 1), including the eastern Sichuan province and Chongqing City, and is surrounded by peripheral mountains (i.e., the Longmen Mts. in the west, Qiyao Mts. to the east, Daba Mts. to the north and Daliang–Dalou Mts. in the south) (Fig. 2) (e.g., Liu, Deng, Li, & Sun, 2012a). Bounded by the current residual terrestrial stratigraphic boundary, the Sichuan Basin covers an area of 18×10^4 km^2, making it one of the four largest basins in China.

The major landmasses in China began to converge during the late Indosinian period (the Late Permian to Triassic) (Zhang, Meng, & Lai, 1995; Ma et al., 2004a). Together with the Laurasian and Gondwanan continents, these landmasses converged to form Eurasia, and the Chinese terrestrial basin formed (Ma et al., 2004a). During the Late Jurassic to Early Cretaceous, the Paleo-Pacific plate was subducted below the Eurasian plate toward the north-northwest (Northrup, Rovden, & Burchfiel, 1995; Zhou & Li, 2000). The South China plate, the north part of the South China Sea plate and the East China Sea plate were subjected to oblique collision and shear orogeny, and the Tibetan plate was extruded eastward (Fig. 1). These movements subjected the southern area of China to multiple strong deformation episodes that formed the South China Yanshanian (Jurassic to early Early Cretaceous) intracontinental orogenic belt and the eastern Yanshanian "plateau" and resulted in widespread magmatic intrusions and volcanic activity in the southeast area and many strike-slip pull-apart basins (Zhou & Li, 2000; Wu, 2006; Chen et al., 2009; He et al., 2011; Wang, Fan, Zhang, & Zhang, 2013b). The tectonic framework of the Sichuan Basin and adjacent areas is restricted to three directions (the northwest, northeast, and southeast), with structural inversion between the east and west. In the Late Cretaceous, the interactions between the Neo-Tethys and the Pacific tectonic domains changed the tectonic character of South China to eastern strike-slip extension and western compressional thrusting, which resulted in the formation of a large number of extensional rifted basins in the Middle–Lower Yangtze and produced large-scale magmatic and hydrothermal activity in the east (Wang et al., 2013b).

2.2. Stratigraphy

The Sichuan Basin is a multi-cycle superimposed basin with a marine carbonate platform and a continental clastic rock system

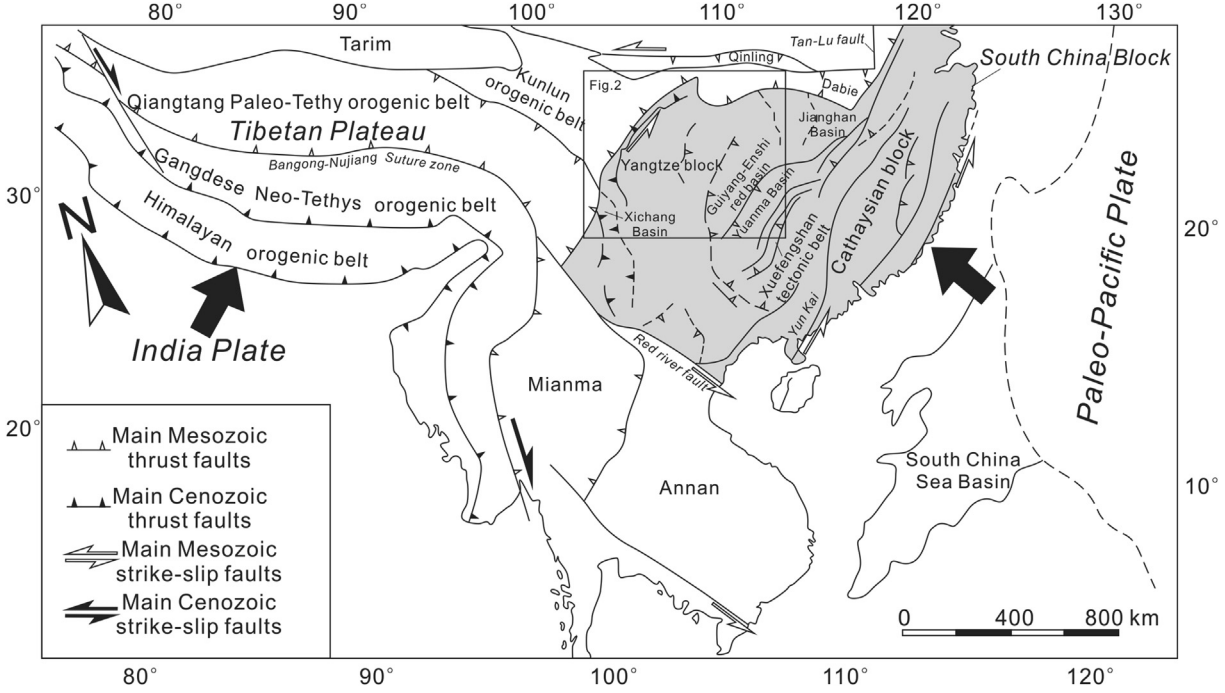

Fig. 1. Location of the South China Block and its relationships with other tectonic units. The box shows the location of the Sichuan Basin (edited after Li et al., 2012a).