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Early Mesozoic structural evolution of the eastern West Qinling, northwest China

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ABSTRACT

This paper aims to reconstruct Early Mesozoic structural development of the eastern West Qinling by integrating structural and geochronologic analyses. The results show that the eastern West Qinling experienced two-phase deformations, separated by a period of tectonic quiescence. Large-scale south-directed displacement of thrust sheets in association with folding characterized the first-phase deformation in Late Triassic time, leading to the formation of the West Qinling fold-and-thrust belt that is composed primarily of Paleozoic–Triassic strata. This fold-and-thrust belt is in general south-convexing arc-shaped, with an accumulated south-directed displacement being over 100 km. The folding and thrusting ended up during the Norian of the Late Triassic Epoch and were immediately followed by widespread granite intrusions. Marked uplift and erosion occurred in the Early Jurassic, resulting in exhumation of the Late Triassic granites. Transpressional deformation took place in the eastern West Qinling in the Middle Jurassic on account of occurrences of strike-slip faulting and refolding. In the easternmost part of the West Qinling exists a Permian–Triassic turbidite wedge that is bordered by a right-slip fault on the northeast and by a left-slip fault on the south, indicating a westward movement that was accommodated by slip faulting. It is argued that collision of the North and South China blocks was responsible for formation of the West Qinling fold-and-thrust belt in the Late Triassic, whereas Middle Jurassic transgression is considered as the result of westward extrusion of Permian–Triassic turbiditic materials from the East Qinling owing to renewed intracontinental convergence between the North and South China blocks. A tectonic model is advanced for Early Mesozoic tectonic development of the West Qinling.

1. Introduction

The Qinling orogen is located between the North China Block (NCB) and the South China Block (SCB), and linked with the Qilian and the East Kunlun belts to the west and the Dabie Shan belt to the east (Fig. 1). The Qinling orogen has long been the focus of studies (Li et al., 1978; Mattauer et al., 1985; Meng and Zhang, 1999; Ratschbacher et al., 2003; Xu et al., 1988; Zhang et al., 1995) because the understanding of its tectonic evolution will help reconstruct history of the Paleotethyan regime in East Asia. Two sutures have been recognized in the Qinling orogen, the Shangdan suture on the north and the Mianlue suture on the south, and they record two-phase collision between the North and South China blocks in the Middle Paleozoic and Mid–Late Triassic, respectively (Meng and Zhang, 1999). The Qinling orogen also underwent intense post-collisional deformation due to continuing NCB–SCB convergence (Chen et al., 2010; Meng et al., 2005; Wang et al., 2001; Xu et al., 2007). Previous studies focused mainly on Mesozoic structural development of the East Qinling (Hu et al., 2012; Shi et al., 2012), with little attention paid to that of the West Qinling.

The West Qinling experienced intense shortening in the Mesozoic, as evidenced by folding and thrusting of Paleozoic–Mesozoic strata. Cenozoic deformation further affected Mesozoic structure of the West Qinling due to northeastward growth of the Tibetan Plateau (Guo et al., 2009; Jiang et al., 2003; Wang et al., 2006a). Mesozoic structural architecture of the West Qinling was established mainly as a result of Late Triassic folding and thrusting, modified by the Late Mesozoic strike-slip faulting to different degrees (Feng et al., 2002; Zhang et al., 2012). However, no detailed structural analyses were carried out to illustrate Mesozoic deformational history. Late Triassic magmatism was particularly active, such as granitoid intrusions (Zhang et al., 2008) and basaltic volcanism (Feng et al., 2002). In addition, Late Mesozoic and Cenozoic intermontane basins of various scales developed throughout the West Qinling (Feng et al., 2002; Jiang et al., 2003; Liu et al., 2007; Zhang et al., 2012), although tectonic histories of these basins remain uncertain.

We investigated Mesozoic structures of the eastern West Qinling in recent years in an attempt to restore its deformational processes by means of structural and chronological analyses. The results show that the eastern West Qinling underwent two phases of deformation, Late Triassic large-scale south-directed thrusting and Middle Jurassic westward extrusion of a Permian–Triassic turbidite wedge. Formation of

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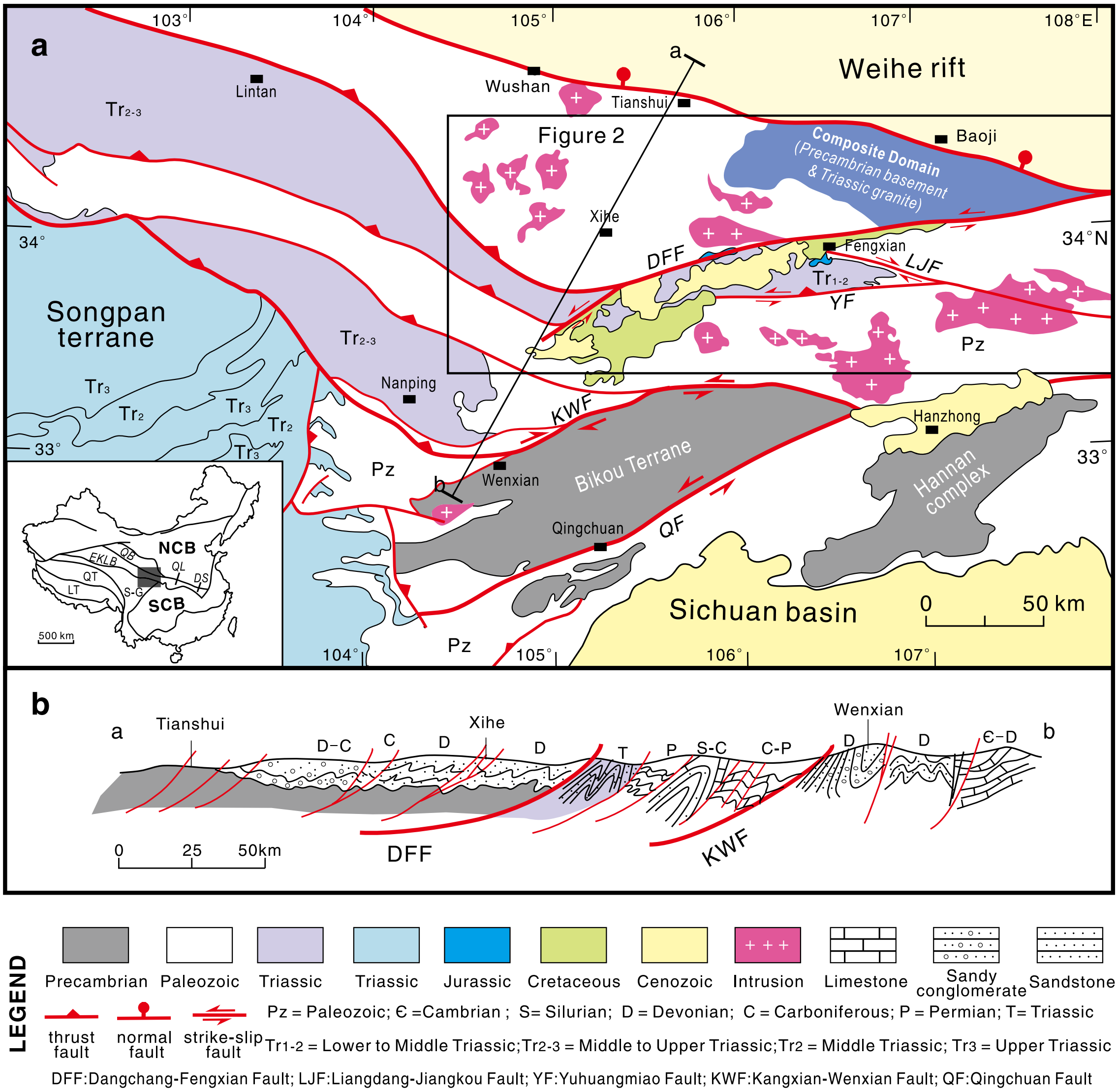

Fig. 1. (a) Simplified tectonic map of the West Qinling; (b) a geological cross section showing fold–thrust deformations from north to south. NCB = North China block, SCB = South China block, SG = Songpan–Ganzi terrane, QT = Qiangtang terrane, LT = Lhasa terrane, QL = Qinling orogen; QB = Qilian belt, EKLB = eastern Kunlun belt, DS = Dabie Shan, DFF = Dangchang–Fengxian fault, YF = Yuhuangmiao fault, LJF = Liangdang–Jiangkou fault; KWF = Kangxian–Wenxian fault, QF = Qingchuan fault.

Late Triassic fold-and thrust belt of the West Qinling is considered the consequence of the NCB–SCB collision, whereas the Middle Jurassic westward extrusion of Permian to Triassic turbidite wedge is interpreted to have resulted from oblique convergence between the NCB and SCB due to renewed clockwise rotation of the SCB (Meng et al., 2005).

2. Structural and stratigraphic framework

The major faults in the eastern West Qinling include the Dangchang–Fengxian fault, the Yuhuangmiao fault, the Liangdang–Jiangkou fault and the Wenxian–Kangxian fault (Fig. 1), most of which are regarded as thrust faults (Feng et al., 2002; Li et al., 2007). Previous studies showed that the present structural architecture of the West Qinling resulted from multistage deformations (Feng et al., 2002; Zhang et al., 2004). Paleozoic–Triassic strata between these faults are strongly folded and faulted in the Late Triassic, but few Precambrian basements crop out. The Jurassic–Cretaceous strata unconformably overlie the underlying rocks, and the Jurassic and Cretaceous are also separated by an angular unconformity in places. Cenozoic tectonism must have affected Mesozoic strata (Guo et al., 2009), which are mostly deformed to various degrees.

The Dangchang–Fengxian fault manifests itself as a curved trace convexing to the south, with the upper-plate Paleozoic strata displaced southward on the Triassic (Fig. 2). The eastern segment of the fault trending ENE serves also as a border fault of an Early Cretaceous intermontane basin that narrows and pinches out to the east (Fig. 1). The NW-striking Liangdang–Jiangkou fault merges with the Dangchang–Fengxian fault to the northwest, with its northwestern segment being largely buried by the Lower Cretaceous (Fig. 2). The Yuhuangmiao fault trends ~E–W and merges into Liangdang–Jiangkou fault to the east (Figs. 1 and 2). The Wenxian–Kangxian fault, the northern boundary of the Bikou terrane, is composed mostly of Proterozoic complexes and minor Paleozoic–Triassic covers (Fig. 1). This fault is regarded to have partially utilized the Mianlue suture and undergone transpressional deformation (Burchfiel et al., 1995; Chen and Wilson, 1996; Chen et al., 2010; Li et al., 2007). The Wenxian–Kangxian fault was active in the Late Triassic, as constrained by $^{40}Ar–^{39}Ar$ ages of 226.9 ± 0.9 Ma and 220 ± 1.4 Ma of muscovites from mylonites (Chen et al., 2010; Li et al., 1999).