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Brittle modification of Triassic architecture in eastern Tibet: implications for the construction of the Cenozoic plateau

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Abstract

In the Songpan-Ganzi Fold Belt, east Tibetan Plateau, post-Triassic deformation is localised within northwest-trending sinistral and southwest-trending dextral brittle fault zones. Between these zones, large tracts of the fold belt preserving Late Triassic (Indosinian) architecture have been transported effectively intact. This transport was almost exclusively strike-slip and did not accommodate significant differential exhumation or uplift. Right-dihedra paleostress reconstructions from fault-plane kinematic data indicate a rotation of the principal compressive stress, from NE–SW-trending in the north to a dominant E–W trend throughout the eastern Songpan-Ganzi fold belt; exceptions occur adjacent to competent Proterozoic basement complexes and other rigid bodies. These stress solutions are consistent with a compressive stress regime that radiates about the Eastern Himalayan Syntaxis. A secondary N–S compressive paleostress, identified in southern regions, may record late southwards transportation of the Songpan-Ganzi fold belt relative to the Eastern Himalayan Syntaxis. The lack of pervasive Cenozoic-Recent upper crustal shortening in this region suggests that thickening of the east Tibetan crust was predominantly accommodated by viscous deformation at depth. We envisage decoupling of the lower and upper crust and partitioning of an E–W compressive stress between: (1) A laterally mobile thin-skinned veneer; and (2) A homogeneously thickened tectonic basement.

Keywords: Brittle deformation; Cenozoic tectonics; Fault analysis; Kinematics; Songpan-Ganzi fold belt; Tibetan Plateau

1. Introduction

The Cenozoic Indo-Asian collision induced numerous lithospheric-scale strike-slip fault zones and major orogenic thrust systems within the Tibetan Plateau (Yin et al., 1999; Tapponnier et al., 1990). Palaeogene thrusting and sedimentation in central Tibet (Wang et al., 2002), Cenozoic faulting and thrusting in southern Tibet (Ratschbacher et al., 1992; 1994) and Tertiary metamorphism around the Eastern Himalayan Syntaxis (Ding et al., 2001) are all records of ongoing modification of the region in response to the collision. A marked Miocene increase in denudation rate about the eastern margin of the Tibetan Plateau is thought to reflect surface uplift in response to crustal thickening (Kirby et al., 2000; Clark et al., 2000; 2004). Reactivation of inherited Mesozoic terrane boundaries allowed north-eastward growth of the plateau (Tapponnier et al., 2001), E–W extension of central Tibet (Yin and Harrison, 2000) and accelerated strike-slip transport to the south and east (Shen et al., 2001). In the eastern Tibetan Plateau, Indo-Asian collision resulted in reactivation of thrusts in the Longmen Shan (Arne et al., 1997) and brittle strike-slip faulting of the Songpan-Ganzi Fold Belt (Wang et al., 1998; Wang and Burchfiel, 2000).

The tectonic architecture of eastern Tibet, comprising the Lhasa, Qiangtang and South China blocks, the Songpan-Ganzi Fold Belt and the Yidun Arc (Fig. 1a), reflects Triassic accretion (Sengör, 1984; Burchfiel et al., 1995; Harrowfield and Wilson, 2005; Reid et al., 2005a). Although granite plutons were emplaced into the central regions of eastern Tibet during the Cretaceous (Reid et al., in press-b), few structures across the region can be unambiguously attributed to post-Triassic but pre-Cenozoic tectonism. A history of episodic pre-Cenozoic thrusting is recorded by thermochronology (Arne et al., 1997) and in foreland basin sedimentation (Chen et al., 1995; Li et al., 2003) within the Longmen Shan, at the eastern margin of the Tibetan Plateau. This reactivation has been tentatively

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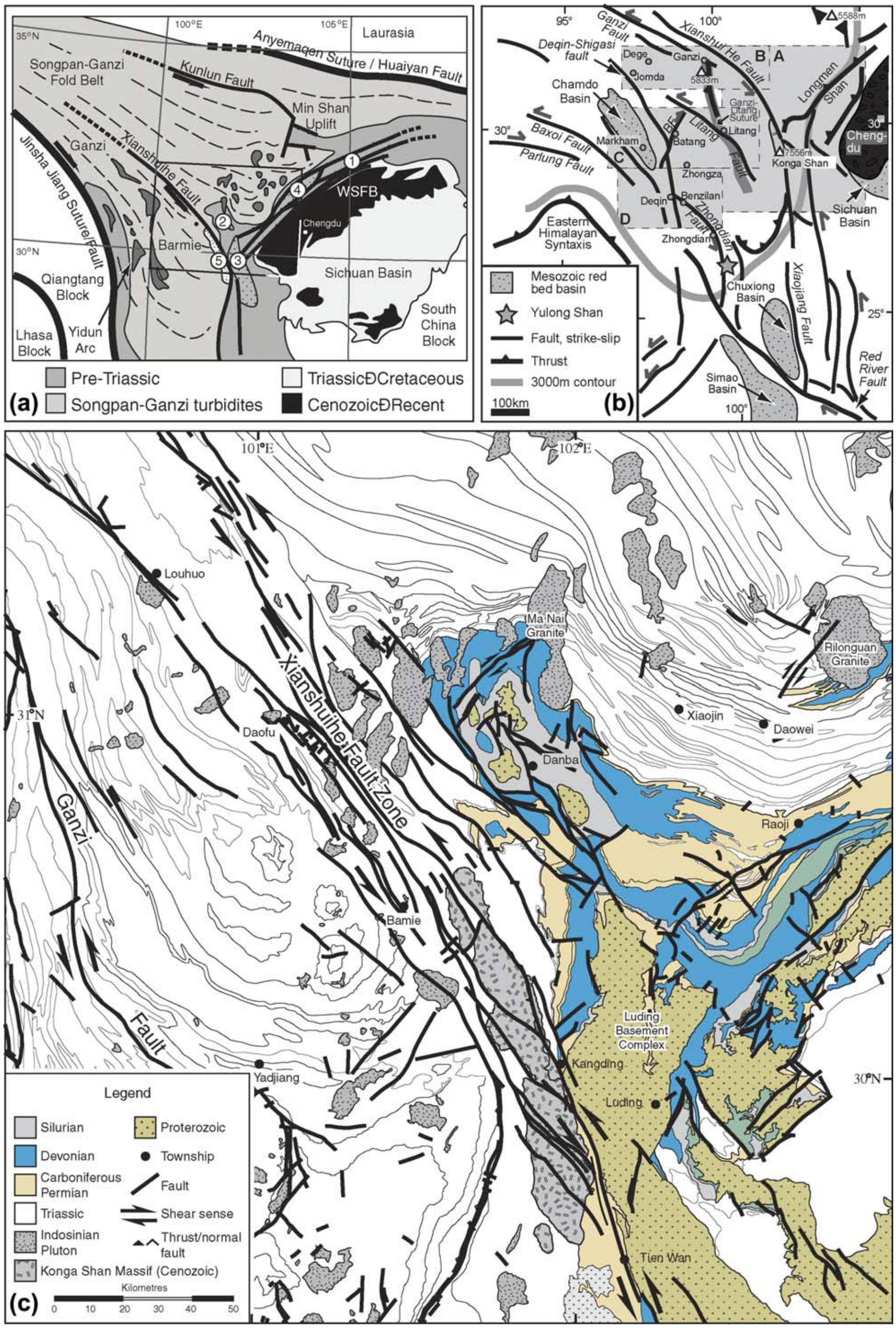

Fig. 1. Tectonic elements across the eastern Tibetan Plateau and surrounding regions. (a) Map showing: (1) the Longmen Shan Thrust Nappe Belt; (2) the Danba Antiform; (3) the Luding Basement Complex; (4) the Peng-Guan Basement Complex; and (5) the Miocene Konga Shan Granite that intrudes the Xianshuihe Fault Zone. WSFB, Western Sichuan Foreland Basin. (b) Major brittle fault zones of the eastern Tibetan Plateau; 3000 m contour shows plateau margin, triangles indicate spot heights above plateau average (∼4500 m). BF, Batang Fault. Shaded areas show the location of the four areas, eastern (A), northern (B), central (C) and southern (D), corresponding to the sections shown in Figs. 7 and 8. (c) Geologic map of the eastern study area, showing distribution of brittle faults, Late Triassic form surface, Indosinian and Konga Shan granites and the distribution of basement rocks. Modified from SBGMR (1981).

correlated with the Lhasa collision (Arne et al., 1997), and pre-Cenozoic deformation is reported from the Lhasa Block to the west (Murphy et al., 1997; Ratschbacher et al., 1992). Nevertheless, most workers in the region agree that Jurassic–Cretaceous tectonism did not significantly modify the Triassic architecture of the eastern Tibetan Plateau (e.g. Burchfiel et al., 1995; Harrowfield and Wilson, 2005; Reid et al., 2005a).