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Chronology and tectonic significance of Cenozoic faults in the Liupanshan Arcuate Tectonic Belt at the northeastern margin of the Qinghai–Tibet Plateau

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ABSTRACT

The Liupanshan Arcuate Tectonic Belt (LATB) is located at the northeastern margin of the Qinghai–Tibet Plateau. Major strike-slip and thrust faults in the Liupanshan area are prominent Cenozoic structures, which are critical in understanding and reconstructing the tectonic deformation history. This paper not only provides detailed investigations on geometric and kinematic characteristics of these faults in the LATB, but also dates the faults' movements by electron spin resonance (ESR). The LATB underwent a succession of compression, extension and again compression tectonic deformation processes since the Cenozoic. The Liupanshan Curved Faults first experienced sinistral strike-slip shear during 57–61 Ma. The Liupanshan Curved Faults responded to the deformation caused by the eastward escape of the Qinghai–Tibet Plateau and acted as the northeastern boundary of the deformation. Timing for the formation of the Liupanshan Curved Faults shows that the collision of the Indian and Eurasian plates must have occurred earlier than these faults' activity because the latter is reflected the far-field effect of the collision.

1. Introduction

The collision of the Indian and Eurasian plates and the associated uplift of the Qinghai–Tibet Plateau is one of the world's most remarkable tectonic events in the Cenozoic. The collisional process caused strong deformation in the Qinghai–Tibet Plateau and formed three major strike-slip fault zones, namely, the Altun Fault Zone in the north of the Qinghai–Tibet Plateau, the East Kunlun Fault Zone, and the Liupanshan Curved Fault Zone (Fig. 1). These faults are regarded as vital structural evidence for sustaining Qinghai–Tibet Plateau eastward motion (Molnar and Tapponnier, 1975; Tapponnier and Molnar, 1976). Studying the tectonic deformation processes of the northeastern margin of the plateau can help us to understand and to constrain the collision time of the Indian plate and Eurasian plate as well as the uplift and deformation process of the Qinghai–Tibet Plateau. We can also explore various models related to plateau uplift processes and mechanisms (Clark and Royden, 2000; Li, 1996; Molnar and Tapponnier, 1975; Mulch and Chamberlain, 2006; Rowley and Currie, 2006; Tapponnier and Molnar, 1976; Tapponnier et al., 2001; Wallis et al., 2003; Zhang, 2008; Zheng et al., 2000), and verify the geological response in western China to the collision of the Indian and Eurasian plates and spatio-temporal variation of the Qinghai–Tibet Plateau uplift.

Previous researchers performed many studies on the tectonic deformation, uplift history, and dynamic mechanism of the northeastern margin of the Qinghai–Tibet Plateau through many different methods and achieved corresponding results (Burchfiel et al., 1991; Chen et al., 2007; Jiang et al., 2007; Lin et al., 2009; Liu et al., 2005, 2010; Song et al., 2001; Zhang et al., 1991, 2005, 2006a; Zhao et al., 2007; Zheng et al., 2006). Previous studies were mostly limited to the late uplift deformation events of the northeastern margin of the Qinghai–Tibet Plateau, and the results demonstrated strong uplift tectonic events in 12–8 Ma in the Liupanshan–Helanshan zone in the northeastern margin (Fig. 1) of the plateau. The time of initiation and details of the remote tectonic deformation in response to the collision of the Indian and Eurasian plates were still unclear.

The aim of this paper is to provide some new geological evidence and chronological data of spatio-temporal constraints on the Liupanshan Arcuate Tectonic Belt. We analyze the geometry and kinematics of the curved faults in this area, restore the paleotectonic stress field using the slickenside plane and fault striae lineation in the fault zone, and discuss geochronological data from quartz veins associated with the fault. Subsequently, we present the tectonic stress field evolution of this area during Cenozoic, and discuss the time limit of activities and dynamic background of these curved faults.

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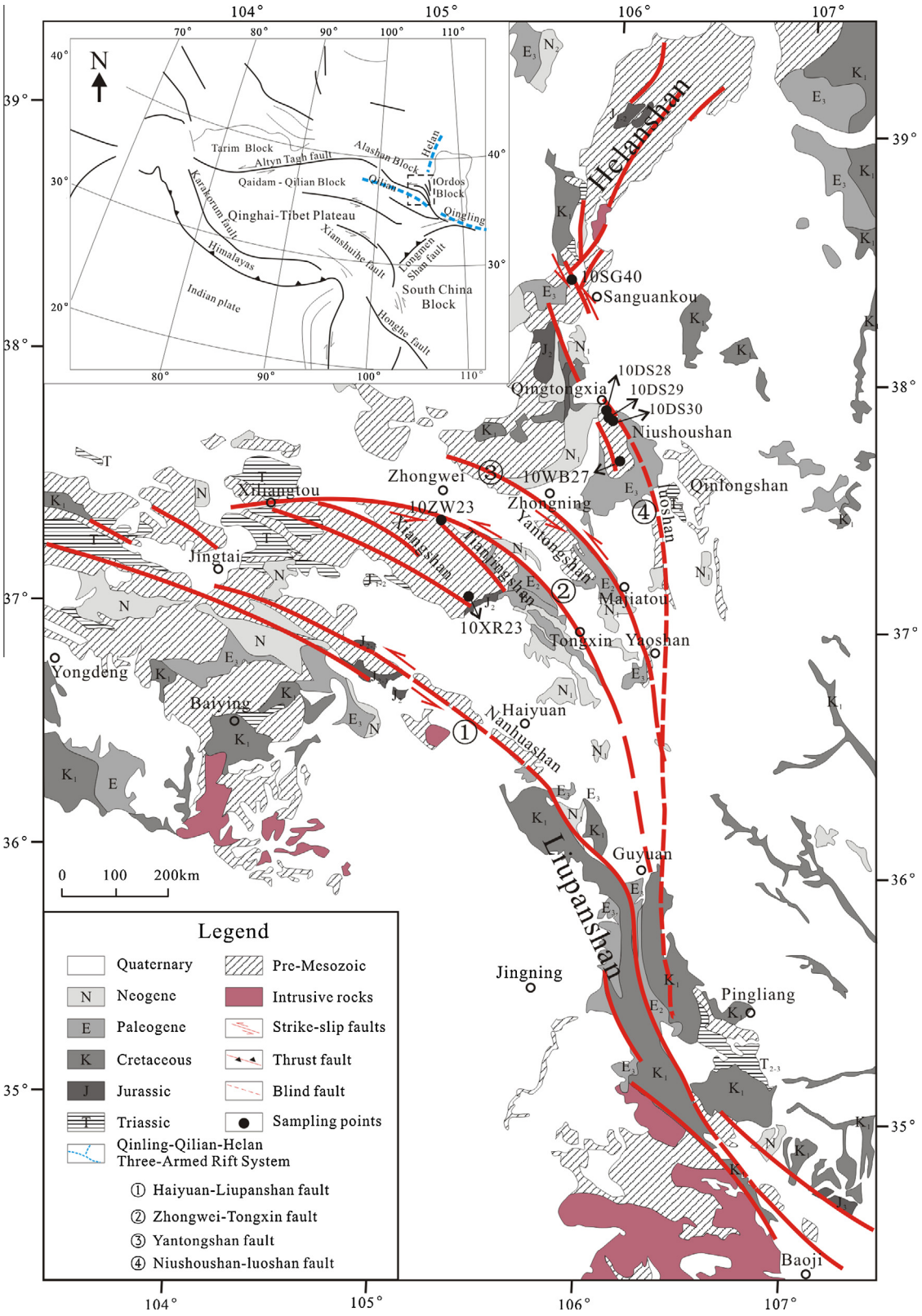

Fig. 1. Geological diagram of the curved faults zone in the Liupanshan area.

2. Geological background

The Liupanshan–Helanshan area underwent multiple tectonic deformations including the Early Paleozoic orogeny, the Indosinian, the Yanshan, and the Himalayan orogeny (Liu et al., 2005; Zhao and Liu, 1990). The early evolution was controlled by the Qinling–Qilian–Helan triple-armed Rift System, which was formed from the Mid- and Neo-Proterozoic to the Early Paleozoic (Lin et al., 1995). Subsequently this area suffered folding due to dextral shear during the Early Paleozoic orogeny. It suffered another strong deformation