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Mesozoic faults in the NE Tarim (western China) and the implications on collisions in the southern Eurasian margin

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ABSTRACT

Paleozoic and Cenozoic deformation events responding to the continental growth in the southern Eurasian margin since the Paleozoic have been well documented in surface and subsurface geology; in contrast, Mesozoic deformation remains poorly known. Based on interpretation of numerous seismic profiles carried out for oil and gas exploration, a Mesozoic transpressional linked fault system has been identified in the NE Tarim, which is composed of (1) the NW–SE-trending Longkou, Ying-S, Ying-N, and Tienan strike-slip faults to the west, (2) the NE–SW-trending and NW-dipping Ying-E 1 and Ying-E 2 thrust faults as well as their branches to the southeast, and (3) to the north, the Weimak fault which can be divided into NW–SE-trending dextral strike-slip segments and NE–SW-trending, SE-verging segments. The unconformity and growth strata related to activity of these faults occurred from the Jurassic to the Cretaceous. This transpressional linked fault system in the NE Tarim block is a kind of intracontinental deformation, attributed to the collisions of the Qiangtang and Lhasa blocks to the southern Eurasian margin from the Jurassic through the Cretaceous.

1. Introduction

The Indo-Asian collision created the Himalayan–Tibetan orogen (e.g. Dewey et al., 1988; Yin and Harrison, 2000). Cenozoic deformation in Central Asia, Mongolian and Baykal regions are generally taken as effects of this collision (e.g. Molnar and Tapponnier, 1975; Tapponnier and Molnar, 1979) and have been focuses in geologic (e.g. Avouac et al., 1993; Charreau et al., 2008) and paleoclimatologic researches (e.g. Molnar et al., 1994), although these active tectonics postdate the collision and are separated by rigid blocks such as Tarim and Junggar, which have accommodated great amount of crustal shortening (e.g. Avouac et al., 1993).

Since the Paleozoic, several microcontinents, flysch complexes, and island arcs have amalgamated onto the southern border of the Eurasia plate (e.g. Yin and Harrison, 2000). Little has been known what kinds of deformation have been induced in the interior of these blocks, although a Mesozoic paleorelief in the northern Tianshan (Chen et al., 2011), Mesozoic cooling events in the southern Tianshan (Zhang et al., 2011) and Mesozoic localized tectonic activity along Paleozoic structures in the Tianshan range (Jolivet et al., 2010) have been recognized. It is not easy to recognize Mesozoic tectonics in central Asia due to intensive reworking of the Cenozoic tectonics in ranges, plains and basins covered by desert and Gobi. However, basins with continuous sediments, such as in Tarim and Junggar, are key sites for answer to the question because of good preservation. Numerous seismic data have been achieved for oil and gas exploration in the Tarim and Junggar basins, and make it possible to understand tectonics building into sedimentary rocks (e.g. Jia and Wei, 2002; Jia, 2004a,b; Jin and Wang, 2004; Lu et al., 2006).

In this study, based on interpretation of numerous seismic reflection profiles, we present structural evidence, a Mesozoic transpressional linked fault system in the NE Tarim block, and interpret it as a remote respondence of the collisions of the Lhasa and Qiangtang blocks to the southern border of the Eurasian plate. This result shed new light on tectonic evolution of the Tarim and central Asia.

2. Geologic setting

The Tarim block experienced rifting during the Early Paleozoic as evidenced by normal faults recognized in seismic profiles, and thereafter it developed as a stable continental block (Jia, 2004a). The Paleozoic strata are up to 15-km thick locally, which is perhaps a product of this rifting. During the Late Paleozoic, the Tarim block collided with the Yili block (Chen et al., 1999; Gao et al., 2009; Wang et al., 2011) and the Junggar block (Charvet et al., 2007) to

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the north, creating the Late Paleozoic Tianshan orogen (Xiao et al., 2004). The North Kunlun (Pan, 1996), Eastern Kunlun–Qaidam (Pan, 1996), Songpan–Ganzi–Hohoxili (Burchfiel et al., 1989b; Dewey et al., 1988; Deng et al., 1996), Qiangtang (Pierce and Mei, 1988; Dewey et al., 1988; Zhang et al., 2002) and Lhasa (Dewey et al., 1988; Matte et al., 1996; Gaetani et al., 1993; Zhang et al., 2004a; Kapp et al., 2005) blocks accreted to the southern margin of the Eurasian continent successively since the Late Paleozoic. Since the beginning of the Cenozoic the Indian continent collided with Tibet, creating the Himalayan–Tibetan orogen (e.g. Dewey et al., 1988). The Tarim block has been generally considered as rigid enough to resist the compression due to these convergent events and thus the deformation of its interior has been believed to be relative weak (e.g. Molnar and Tapponnier, 1975; Tapponnier and Molnar, 1979).

Well loggings and outcrop geologic observations reveal that Phanerozoic sedimentary rocks cover the Tarim (Zhang et al., 2004a,b). In the NE Tarim, the Cambrian consists of gray thick-bedded argillaceous limestone intercalated with gray thick-bedded mudstone, black thick-bedded siliceous pyrite-bearing mudstone, and gray thick-bedded siliceous nodules and pyrite-bearing siliceous dolomite. The Ordovician is made up of thick brownish gray and fine-grained sandstone intercalated with thin-bedded siltstone. The Lower Silurian is composed of light gray siltstone intercalated with muddy siltstone. The Middle–Upper Silurian, Devonian, Carboniferous, Permian and Triassic are generally absent. However, intensive magmatism occurred in the Tarim in the Permian (Chen et al., 1997; Yu et al., 2009). In some seismic reflection profiles, it can be observed that basalt sills intrude in Paleozoic sedimentary rocks, some of them are parallel to beddings and some pierce through beddings vertically or obliquely. The Lower and Middle Jurassic are divided into the Kezilenuer, Yangxia and Ahe Formations in an ascending order. The Kezilenuer Formation is composed of grayish green mudstone intercalated with sandy conglomerate and thin-bedded coal layers. The lower part of the Yangxia Formation is of grayish green siltstone bearing mud pebble or argillaceous siltstone; and the upper part is of gray siltstone and brownish red argillaceous siltstone and mudstone. The lower part of the Ahe Formation is made up of coarse-grained gravel-bearing sandstone and siltstone, and the middle part is of grayish green mud gravel-bearing siltstone, and the upper part is composed of greenish gray pebble-bearing sandstone. The Upper Jurassic consists of gray medium-grained sandstone, siltstone, and conglomeratic sandstone intercalated sandy mudstone. The Upper Jurassic is absent. The Lower Cretaceous is divided into the Bashijiqike Formation and the Kapusaliang Group in an ascending order, which are composed of sandy conglomerate and medium-grained sandstone intercalated with mudstone and argillaceous siltstone. The Upper Cretaceous is generally absent. The Lower and Middle Paleogene (the Kumugeliemu Group) are composed of yellowish brown silty mudstone and argillaceous siltstone. The Late Paleogene Suweiyi Formation consists of yellowish-red fine-grained sandstone and siltstone. The Neogene is divided into the Jidike, Kangcun and Kuche Formations from old to young, which are composed of brick red–grayish green gypsum-bearing mudstone, and siltstone intercalated with gritstone. The Quaternary is of primrose yellow clay, weakly lithified.

3. Structures in the NE Tarim block

In the NE Tarim, five main faults are identified, including the Longkou, Ying-S, Ying-N, Weimake, and Ying-E1 and Ying-E 2 faults. The first three faults are dominantly NW-trending; in contrast, the last two are NE-trending. Several anticlines are found at restraining bends or overlaps of the faults in this transpressional

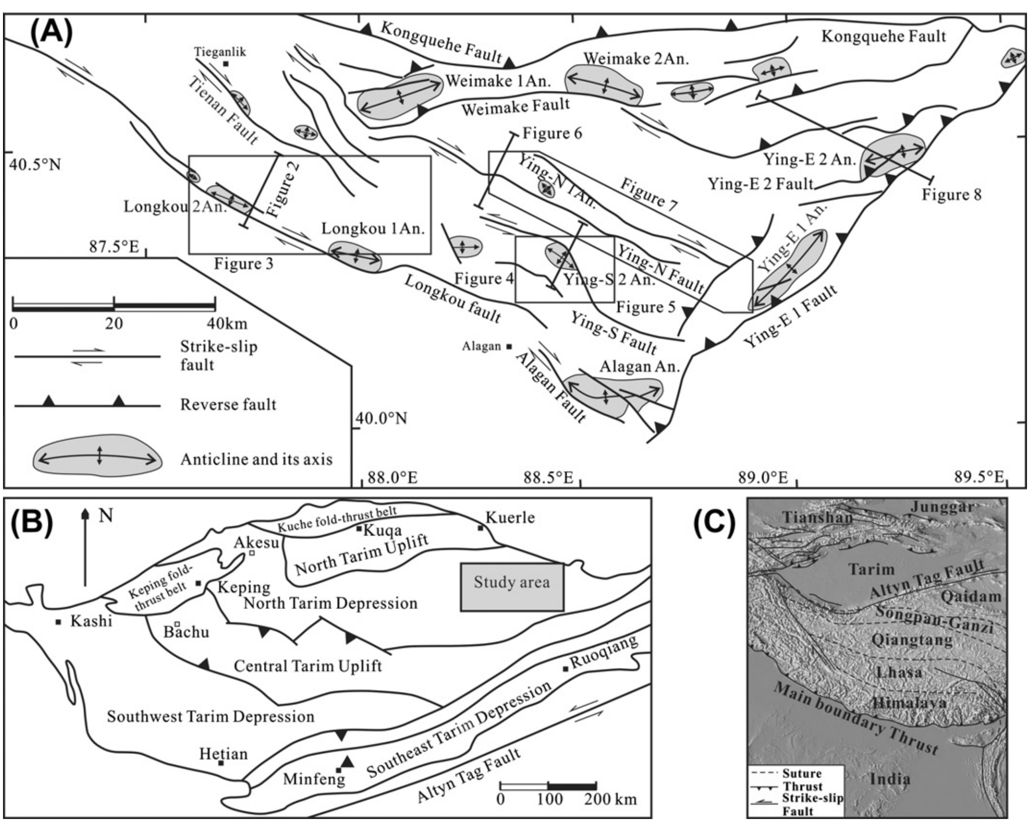

Fig. 1. (A) Mesozoic structural outline of the NE Tarim. Faults and anticlines displayed in this map are recognized through seismic interpretation. (B) Structural units of the Tarim basin (Jia, 2004a). (C) Study area relative to the Eurasian plate.