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Features and effects of basement faults on deposition in the Tarim Basin

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ABSTRACT

The Tarim Basin, as the largest inland, oil-producing basin in China, is a large-scale composite basin, which formed from a Palaeozoic craton basin that was overprinted by a Mesozoic–Cenozoic foreland basin. Based on comprehensive analyses of gravitational data, aeromagnetic data and seismic data from the basin, 38 basement faults can be identified, demonstrating that the Tarim Basin has undergone several tectonic cycles. According to their distributional locations in the basin, basement faults can be divided into marginal and internal basin basement faults. Moreover, on the basis of the distribution characteristics in the plane and controlling effects on the basin, the basement faults can be divided into 20 primary basement faults and 18 secondary basement faults. Combined with the interpretations of seismic profiles, we can determine the relationship between the basement faults and sedimentary cover faults. Considering the section balance of seismic profiles, we find that some basement faults are syn-depositional with continuous long-term activity during the basin's evolution and control the deposition in the basin. By counting fault growth indexes of the main sections, it is obvious that different parts of the same fault have different growth indexes but show similar activity within the same geological period. The faults' stress states remain consistent with their geological history, although the growth indexes of different faults are inconsistent.

Contents

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1. Introduction

The Tarim Basin is located in the southern part of Xinjiang Uygur Autonomous Region between Tianshan Mountains and Western Kunlun–Altun Mountains. The Taklimakan Desert lies at the centre of the basin and is circled by a series of secondary mountains, including Kuruktag Mountains, Keping Mountains, Tiekelike Mountains and Altun Mountains. Tarim Basin is the largest inland-basin in China, with an area of approximately 560 000 km^2. The Tarim plate is an old craton terrane with a diamond shape (Fig. 1). The basin's boundaries are distinct: its northern boundary is the Hentengri Pk.–Balguntay–Kumux fault, which separates it from the Kazakhstan–Junggar Plate, its southeastern boundary is the Altun strike-slip fault, which separates it from the Qaidam terrane; its southern boundary is the South Kunlun fault, which separates it from the Qiangtang terrane; and its southwestern boundary is the Talas–Fergana and Kangxiwar faults, which separate it from the Kohistan–Gangdese plate (Watson et al., 1987; Hendrix et al., 1992; Liu et al., 1994; Carroll et al., 1995; Jia et al., 1995; Jia, 1999; Bosboom et al., 2011). The terranes' activity is considered as the main reason for basement faults' wide distribution throughout the basin's long geological evolutionary history (Xu et al., 2002; Ma et al., 2009). Researchers have studied the faults for many years, but there are still some unsolved problems: (i) recently, some researchers are focusing on the identification and study of the basement faults in the Tarim Basin (Tang, 1989; Hu, 1995; Tang, 1997; Xu, 1997; Zhang and Tian, 1998; Guo and Zhang, 1999; Wei et al., 2006; Ding et al., 2012); however, only few studies have covered the basin on a large scale; (ii) there are many ways to identify faults, such as gravimetric method (Xu et al., 2005; Hou and Yang, 2011), aeromagnetic method (Xu et al., 2002; Yang et al., 2012b), and seismic profiles (He, 1995; Ji, 2008; Tang et al., 2012a,b), but previous research has adopted only one of these methods to study basement faults; (iii) many classifications can be used to divide basement faults (Reches, 1978; Tang and Jin, 2000), but there is not a clear classification to grade the basement faults in the Tarim Basin; and (iv) basement faults have distinct controlling effects on tectonic movement and magmatic activity (Li and Gao, 2010; Tong et al., 2010, 2012; Gao et al., 2013; Xu et al., 2013), but the relationship between the basement faults and later sedimentary cover faults is unknown. In this paper, we mainly utilize gravimetric data, aeromagnetic data and seismic profiles to identify basement faults. Moreover, we conduct basin deposition research through interpretations and section balance of the seismic profiles.

2. Features of the basement faults

The Tarim Basin is a large-scale superimposed basin. Abundant research on the basin has been performed, including processing of the Tarim Basin's aeromagnetic data, characteristics of its tectonic evolution, tectonic framework of the basement and basal evolution, and the relationship between hydrocarbon accumulation and faults (Wang and Tan, 1981; Kang and Kang, 1996; Jia, 1997; Duan and Xu, 1998; Guo and Zhang, 1999; Jia, 1999; Xu et al., 2002; Kang, 2004; Xu et al., 2005; Cai, 2007; Ji, 2008; Wang et al., 2009; Pu et al., 2011). Based on a previous study, we can come to some significant conclusions: (i) faults can be identified from some obvious features visible in the aeromagnetic or seismic data; (ii) early-inactive faults play an important role in controlling post-basin evolutionary development; and (iii) large faults' distribution plays a significant role in the distribution of igneous rocks and sedimentary cover faults, the formation of traps and the division of tectonic units. In this paper, we consider that the Tarim Basin began to receive deposition during the Sinian period, whereas we regard the pre-Sinian as the base (Fig. 2). Thus, we define the fault that cuts through both the base and sedimentary covers as the basement fault, and the fault that only cuts through sedimentary covers as the sedimentary cover fault.

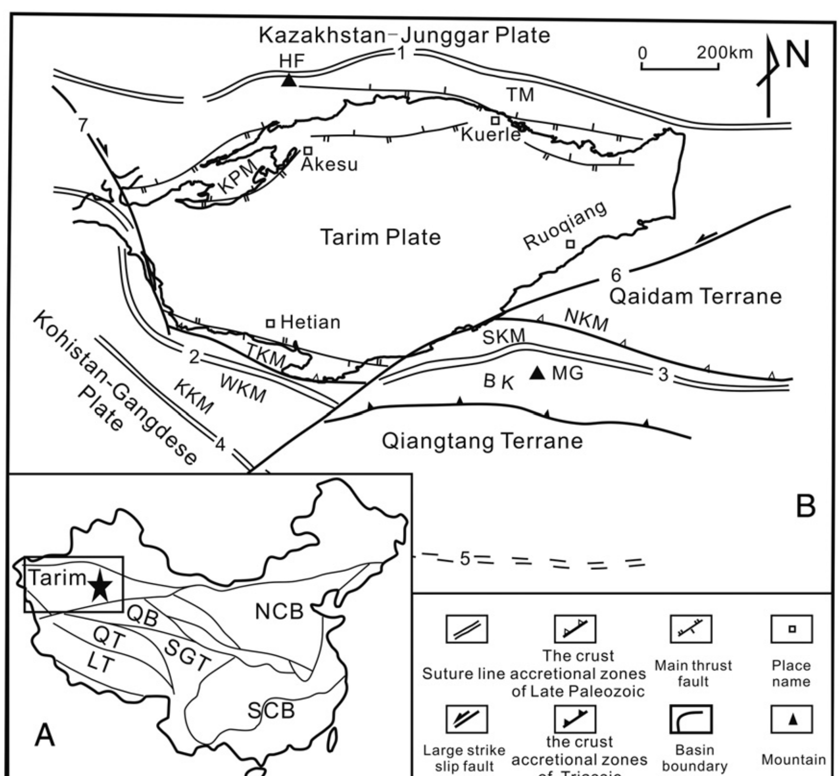

Fig. 1. (A) Main tectonic elements of China. NCB: North China Block, SCB: South China Block, SGT: Songpan–Ganzi terrane, QB: Qaidam Basin, QT: Qiangtang terrane, LT: Lhasa terrane (modified from Zi et al., 2008). (B) Schematic diagram of the Tarim Basin's tectonic position (modified from Liu et al., 1994). HF: Hantenggelifeng, MG: Muzitage, BK: Bayankashi-Kekexili, TM: Tianshan Mountains, KPM: Keping Mountain, TKM: Tiekelike Mountain, KKM: Kalakunlun Mountain, WKM: West Kunlun Mountain, SKM: south Kunlun Mountain, NKM: North Kunlun Mountain; 1. Hentengri Pk.-Balguntay-Kumux fault; 2. Kangxiwar fault; 3. South Kunlun fault; 4. Konggur Pass fault; 5. Banggong-Nujiang fault; 6. Altun fault; 7. Talas-Fergana fault.