The Quaternary Dextral Shearing in the Southeastern Tibetan Plateau

SHEN Jun  Wang Yipeng  REN Jinwei  CAO Zhongquan
Institute of Geology of China Seismological Bureau, Beijing 100029, China
Tel:8610-62009121, Fax:8610-62028617; Email:shenjuneq@263.net

Abstract: The field study on the Jiali fault zone in the southeast of Tibetan Plateau and the Deqin-zhongdian-Daju fault in the northwest of Yunnan province, China indicate that there is no integrated dextral shearing zone defining the south boundary of the eastward extrusive Plateau. The western segment of the Jiali fault zone is the transform fault with high slip rate between grabens in south Tibet, which is a W-E extension region under the N-S compression. The Deqin-Zhongdian-Daju fault, together with the Red River fault, defines the southwestern boundary of the southeastward escaping rhombic Sichuan-Yunnan Block which is south part of the eastward escaping main body of the Tibetan Plateau. The southern crust of the Tibetan Plateau is more plastic and easier to flow eastward due to the higher temperature. Unlike the northern boundary of the Tibetan Plateau, on where large left lateral strike slip faults developed, in southern Tibetan Plateau, many smaller right lateral slip faults distribute in a very wide belt in stead of an integrated fault.

Key words: Tibetan Plateau, Jiali fault zone, Dextral Shearing Zone, eastward extrusion

1. Introduction

The convergence between the India and the Asia induced the intensive deformation in the Tibetan Plateau. In the late Cenozoic, the Tibetan Plateau undergoes the deformations of various styles (Wang, 1996). The first is the crustal shortening, thickening and uplifting of the plateau under the N-S compression(Chang,1988), resulting in nappes or thrust faults on the piedmonts of the boundary mountains in and surrounding the Plateau. The second is the collapsing and extension of the Tibetan Plateau, resulting in grabens and detachment faults in the southern and central Tibetan Plateau. The third is the Eastward extrusion or escaping of the main body of the Tibetan Plateau(Tapponnier, 1976,1977,1979,1982). The last is the clockwise rotation of the E-W orientation tabular blocks in the Tibetan Plateau, resulting large left lateral strike slip fault in the eastern edge of the plateau(England, 1990).

The eastward extrusion/escaping is important, even though there are many debates among the geologists on its magnitude, mechanism. The lateral extrusion/escaping of the main body of the plateau forms the large shearing zones along the boundary and between tabular secondary blocks. The sinistral shearing zones in the north are obvious and recognized by many geologist, such as the Altyn Tagh Fault Zone along the north boundary of Tibet Plateau (slip rate 10-30mm/a), the
East Kunlun Fault Zone (slip rate 10mm/a) and the Xianshuihe-Xiaojiang Fault zone (slip rate 10-15mm/a) (Van, 1998). The Quaternary dextral shearing zones in southern Tibetan Plateau are also recognized. One is the Red River Fault zone in Yunnan Province of China (3-5mm/a)(Allen, 1989). It is a right lateral strike slip fault since late Pliocene. Another is the Karakorum Fault zone along the west edge of the Tibetan Plateau. In addition, it is supposed there is a dextral shearing zone in southern Tibetan Plateau (Fig.1), consisting of several WNW right lateral strike slip faults, include the Peng Co fault, Coring Co Fault (Amijio, 1986).

Fig.1 The eastward extrusion of Tibetan Plateau proposed by Armijio et al. (1986)

How far can the dextral shearing zone in the south Tibetan Plateau extend eastward? Can it connect with the Red River Fault and form an integrated southern boundary dextral shearing zone of the eastward extrusive main body of the Tibetan Plateau? In the past three years we investigated in southeast Tibet and northwest Yunnan province, China. Jiali right lateral strike slip fault, Daju right lateral strike slip fault and the area between them were studied. The goal is to make sure if there is an integrated dextral shearing zone defining the south boundary of the eastward extrusive Tibetan Plateau.

2. Study method

Satellite images, air-photographs and large scale DEMs (digitized elevation maps) were used to analyze the fault induced morphologic deformation, find the distribution of the fault. Field investigation was to find more direct evidence of displacement, map the typical deformation phenomenon, collect dating samples and analyze the brittle and ductile rupture zone, the deposit in the fault zone, the fault outcrops, deformed rock layers close to the fault. C\(^{14}\) and TL(Thermoluminescence) dating methods were used to get the deformation age. In order to get a more convincing estimation on the slip rate of the strike slip faults, regional analysis on the ages of the deformed morphological terraces were made. The relationship between the ages of terraces and streams with the climate changes were set up.

3. Jiali right lateral strike slip fault in southeast Tibet

Jiali fault zone is the southeast part of the right-lateral strike-slippping Karakurom-Jiali fault zone supposed by Armijio et al. (1989). The geometry of the Jiali fault is composed of three segments. The northwest segment is the NW trending right-lateral strike-slippping faults, which are accompany with the NNE oriented grabens and semi-grabens in central Tibet. The middle segment is the NWW trending right lateral strike slipping faults along the Yigung Zangbo River. The southeast segment is the Tungmai-Xiaochayu fault. The Quaternary active faults in the east of Jiali fault zone is NW or NNW trending right lateral strike slip normal faults. Such as the Ranwu fault.

The NW trending strike-slippping faults have many similar characteristics of the same trending faults in the extensional area in the south Tibet, such as the Peng Co
fault and Curing Co fault. Those fault bounded the end of the grabens or semi-grabens in south Tibet and have more clear morphological evidences of faster right lateral strike slipping sense in the boundary of the grabens and semi-grabens, and diminish quickly apart from the grabens or semi-grabens(Ren,2000; Shen,2001a). The NE trending faults adjoined to the NW trending faults is also highly active and formed many fresh fault scarp and large dip slipping at the sides of the grabens, such as the Daren and Sangdi basins in the northwest segment of Jiali fault.

The right lateral strike slipping sense along the NWW trending fault in the middle segment of the Jiali fault is not very clear either in morphology and geology(Shen,2001a). We researched the drainage and ridge offsets supposed by Armijio et al(1989), and found them were isolated phenomena which might not make the convicive evidences of the right lateral strike slipping at the rate up to 10~20mm/a as Armijo et al. estimated.

Judging from the data of field measurement and Dating samples, we estimated the right lateral strike-slip rate of the NW trending fault in the northwest part of Jiali fault zone up to 10mm/a since late Pleistocene and 6~8mm/a since middle Pleistocene, while that of the NW trending secondary fault in the middle segment of the fault zone is no more than 2-3mm/a.

4. Deqin-Zhongdian-Daju right lateral strike slip fault in northwest Yunnan

Deqin-Zhongdian-Daju fault is a 300km long NW trending right-lateral strike-slip fault, from Deqin to Yongsheng in Yunnan Province, China. It is consisted of 4 segment. Zhongdian basin and Daju basin formed along the fault. The fault initiated since late Pliocene or early Quaternary(Shen, 2001b).

The largest offsets is about 2.5 km. Drainage offsets of various scales can be found in the southeast of Deqing, the north boundary of Zhongdian Basin, east to Xiao-Zhongdian valley, the north piedmont of Haba snow capped mountain, the Daju basin and Dadong valley. The observed offsets are formed since middle Pleistocene. The average slip rate since middle Quaternary is 4-6mm/a.

Together with the Red River fault, it is the south boundary of the southeastward extrusive Sichuan-Yunnan massif. It combined with the Lancangjiang fault in the west, and doesn't cross the Henduanshan Mountains of southeast Tibet. It is impossible to connect the Deqin-Zhongdian-Daju fault with the Kalakun-Jiali fault.

5. Conclusion and discussion

There is not a continuous large slip rate boundary dextral fault of the extrusive Tibetan Plateau. The deformation mechanism of the Tibet plateau is far more complex than what have predicted before. However, this is not contrary with the fact of the large scale eastward escaping of the Tibetan Plateau. The escaping main body is the northeast Tibetan Plateau, roughly the Qiadam Massif and Bayan Har Massif(Fig.2). The north boundary is Altun Tag Fault. The south boundary are Kekexili mountains, the Tanggula Mountains and the Tiantantaweng Mountains, instead of the Kalakunlun-Jiali fault zone. The east-west extension of the southwest part of the Tibetan Plateau take place of the large slip rate south boundary dextral fault. The
WNW trending right lateral strike slip fault in south Tibet, include the Beng Co fault, the Cering Co fault and the northwest segment of Jiali fault, are transform fault, resulting from the E-W extension of the southwest Tibetan Plateau.

Fig. 2 The eastward escaping model of the Tibetan Plateau

The different dynamics environment between the southern and the northern Tibetan Plateau makes the different deformation style in the two region. The southern crust of the Tibetan Plateau is more plastic and easier to flow eastward due to the higher temperature. Unlike the northern boundary of the Tibetan Plateau, on where large left lateral strike slip faults developed, in southern Tibetan Plateau, many smaller right lateral slip faults distribute in a very wide belt in steady of an integrated fault.

Reference
Armijo, R., P.Tapponnier, J.L. Mercier, and T. Han, 1986, Quaternary extension in southern Tibet: field observations and tectonic implications, J.G.R., 91(B14): 13803~13872
Armijo, R., P. Tapponnier, and T. Han, 1989, Late Cenozoic right-lateral strike-slip faulting in southern Tibet, J.G.R., 94(B3): 2787~2838
Chang Chengfa, Robert, M Shachleton et al., 1988,The geological evolution of Tibet, London: The Royal Society, 1~413
Molnar, P., P. Tapponnier, 1975, Cenozoic tectonics of Asia: effects of a continental collision, Science, 189:419~426
Tapponnier P. and Molnar P., 1976, Slip-line field theory and large scale continental tectonics, Nature, 264,319
Tapponnier, P., P. Molnar, 1979, Active faulting and Cenozoic tectonics of the Tian Shan, Mongolia and Baykal regions, J.G.R., 84(3): 3425~3459
Tapponnier, P., ET al., 1982, Propagating extrusion tectonics in Asia: new insights from simple experiments with plasticine, Geology, 10: 611~616
Van Der Woer, J., F. J. Ryerson, P.Tapponnier, et al., 1998, Holocene left-lateral left-slip rate determined by cosmogenic surface dating on the Xidatan segment of the Kunlun fault Qinghai, China, Geology, vol.26, no.8, p.695~698