The deep process of the collision structure in northern Tibet revealed from investigation of the deep seismic profiles

Gao Rui*, Li Qiusheng, Guan Ye, Li Pengwu and Bai Jin

Institute of Geology, Chinese Academy of Geological Sciences, Beijing 100037, CHINA

** To whom correspondence should be addressed. E-mail: gaorui@cags.net.cn*

In recent years, the crust and upper mantle structure of the northern Tibetan plateau has already attracted wide attention from geologists throughout the world. The collision generates not only in the southern Tibetan plateau but also in the northern part. The Tarim basin as a continental block not only has been obstructing the collision from the Indian continent, but also may have been subducting beneath the Tibetan plateau and generating collision, but the scale and deep process have not been fully understood yet. Therefore, probing the deep structure of the collision boundary in the northern Tibetan plateau is of special significance to comprehend the deep process of the intra-continent deformation caused by collision.

Since 1993, deep geophysical investigations have been carried out along the northern margin of Tibet across the basin-and-range conjectures. They include several deep seismic reflection profiles, wide-angle reflection and refraction profiles as well as broadband regional observation. They revealed the lithospheric structure of the northern margin of the Tibetan plateau at different tectonic layers. Some profiles and interpretations in detail will be discussing in this paper.

(1) The reflection image of the southward Tarim block subduction at a steep angle was found both in the West Kunlun (Gao et al. 2000) and Qilian profiles (Gao et al. 1995, 1999). In the Altyn profile, the shearing at a lithosphere scale constrains the subduction of the Tarim crust beneath the Tibetan plateau, but the Tarim mantle has already subducted beneath the plateau (Gao et al. 2001).

(2) Many groups of stronger reflections, dipping northwards under the west Kunlun Mts. and southwards under the southern margin of the Tarim basin, constitute the evidence for the collision between the Tarim basin and the Tibetan plateau (Gao et al. 2000, Kao et al. 2001). The image of reflection structure reveals the V-shaped basin-and-range coupling relationship between the west Kunlun Mts. and the Tarim basin on a lithosphere scale.

It should be particularly pointed out that a face-to-face collision pattern has not been found under the lithosphere of Tibetan plateau before. Based on the comparison of the face-to-face compression model with the deep seismic reflection profile of the Indian continent subduction beneath the southern Tibet and the seismic research of subduction residuals of the Tethys oceanic crust found under Yarlungzangbo suture, the authors consider that the north-dipping reflection under the west Kunlun Mts. should be caused by the subduction of the continental lithosphere. Although it cannot be determined whether it comes from India or Eurasia, a continental lithosphere is thrusting northwards along this thrust fault.

(3) The deep process of the normal collision and deformation are different from that of oblique collision. West Kunlun and the Qilian Mts. are both located at the position of collision and deformation, where the lithosphere of the Tarim is subducting southwards. Because West Kunlun is relatively close to the Indian plate, the Tarim lithosphere collided with the north-subducting Indian lithosphere under West Kunlun as the former subducted southwards for a short distance. The Altyn Mts. featuring oblique collision and deformation constrains the deep subduction of the Tarim crust beneath the Tibetan plateau because of strike-slipping and shearing of the lithosphere. However, in the mantle lid, low-angle south inclining reflections may reflect that the Tarim mantle has already subducted beneath the Tibetan plateau and resulted in detachment structure at the bottom of the crust. This may be the deep effect of the oblique collision.

(4) In the west Kunlun-Tarim and Qilian profiles, a thrust deformation zone has developed for about 50 km from the piedmont to the basins. And in the Altyn–Tarim profile, the deformation zone is about 120 km in width. This may be related to the angle of subduction and collision. In the Himalayan, the thrust deformation zone is about 200 km in width (Chen et al. 1999). The Indian plate is subducting along the MBT at a low angle. Therefore, deep processes of the collision deformation are different between the northern margin and southern margin of the Tibetan plateau.

References

Chen WP, CY Chen and JL Nabelek. 1999. Present-day deformation of the Qaidam basin with implications for intra-continental tectonics. *Tectonophysics* **305**: 165-181

Gao R, X Cheng and Q Ding. 1995. Preliminary Geodynamic Model of Golmud—Ejin Qi. *Geoscience Transect, Acta Geophysica Sinica (in Chinese)* **38** (II): 3-14

Gao R, X Cheng and Q Ding. 1999. Lithospheric structure and geodynamic model of the Golmud-Ejin transect in northern Tibet. *Geol. Society of America Special Paper* **328**: 9-17

Gao R, D Huang and D Lu. 2000. Deep seismic reflection profile across Juncture zone between Tarim basin and west Kunlun Mountain. *Science Bulletin* **45**(17): 1874-1849

Gao R, P Li, Q Li, Y Guan, D Shi, X Kong and H Liu. 2001. Deep process of the collision and deformation on the northern margin of the Tibetan plateau: Revelation from investigation of the deep seismic profiles. *Science in China* **44**(D): 71-78

Kao H, R Gao, RJ Rau, S Danian, R Chen, Y Guan and TW Francis. 2001. Seismic image of the Tarim basin and its collision with Tibet. *Geology* **29**(7): 575-578