STRONG TECTONIC AND WEAK CLIMATIC CONTROL OF THE GEOMORPHOLOGIC AND GEOLOGICAL FEATURES IN WEST KUNLUN

Bin WANG[1, 2] Hong CHANG[1]

(1 State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710075, Shaanxi, China; 2 Graduate School of Chinese Academy of Sciences, Beijing 100039, China; Fax: 86-29-88320456, e-mail: binwang19841010@163.com)

Abstract

Constituting the northwestern margin of the Tibetan Plateau, the present-day West Kunlun is a spectacular mountain range, extending from the Pamir Plateau in the west to the Altyn Tagh fault and the East Kunlun Range in the east [1]. West Kunlun Mountains lie in inland arid areas of Central Asia far from the oceans. Severe temperatures have a significant annual and diurnal temperature difference, but the orographic precipitation of the northern slope of West Kunlun can still be a few hundred millimeters per year. Temperature and precipitation also show clear vertical zonation. It developed a lot of fast-flowing rivers in the foothills and large number of glacier and frozen soil in high mountain areas of the West Kunlun. Strong winds with gravel bring serious erosion. Dramatic climate variations have a significant control on the fluvial dissection, glacial erosion and wind transport [2,3].

The West Kunlun Mountain is one of the key regions for understanding the uplift history of the Plateau and the climate change of Central Asia. The activities of tectonism and erosion make the topography of West Kunlun Mountain complex and varied [4]. However, due to its remote location, there is still limited knowledge about the geomorphologic and geological features in West Kunlun Mountain. This paper tries to figure out the geomorphologic and geological features of this region qualitatively through studying the data of Shuttle Reader Topography Mission (SRTM) and topographic maps by digital elevation models (DEMs) and constructing profiles, aiming to make clear what functions the tectonism and climate exert on the topography of the West Kunlun Mountain.

The West Kunlun Mountain, the northwestern margin of the Qinghai-Tibet Plateau, have strong tectonic activities. From south to north，West Kunlun Mountain developed three major faults: Kangxiwar fracture, North West Kunlun fault and Iron Creek fault [1,5]. At about 25 Ma B.P., the West Kunlun began to uplift, and from about 5 Ma B.P., the West Kunlun began to grow rapidly [5]. By using topographic analyzing software to make more than 10 vertical profiles across the main faults from south to north, it is obvious that there is a height difference between the upper and lower plate fracture, and the elevation of terrain profiles generally decreases from south to north. There is ~4,500m elevation difference between the main ridge of the West Kunlun Mountain out of Kangxiwar (5500-6000m) and the northern foot of the Tarim Basin (1200-1300m). The same progressively decreasing trend is also found from west to east. According to the previous studies, there are 5500 meters, 4000 meters and 2000 meters elevation of the three major surfaces in the West Kunlun region by the SRTM maps [5,6,7]. They probably formed in different periods of tectonic uplift, when ancient planation surfaces were eroded. It need further study to confirm which factors control these processes.

The study area developed a number of rivers due to glaciers and orographic precipitation. Most of them flow north into the Tarim Basin, with tectonic activities playing significant roles on their flow direction and development patterns. By using longitudinal section maps of major rivers and topographic profiles of drainage area, we find that rivers' longitudinal sections match well with structural phenomena of drainage. The rivers cut through a large number of valleys due to high gradient. The shaping of the erosion features was also largely influenced by the glaciations[8,9]. In particular, spatially variable erosion resulting from climate gradients may localize exhumation and deformation in orogens and thereby influence the geologic structure and morphology of mountain ranges [10,11,12].

Our results support the view that tectonics formed the basic pattern of geological features and is the first-order control on the morphology of the West Kunlun Mountain. Climate variations play a significant role in the geomorphologic formation.

Keywords: West Kunlun, geomorphologic, tectonics, climate, erosion.

References

[1] Xiao Wenjiao, Han Fanglin, Brian F. Windley, Yuan Chao, Zhou Hui, Li Jiliang. Multiple Accretionary Orogenesis and Episodic Growth of Continents: Insights from the Western Kunlun Range, Central Asia. International Geology Review 45, 303–328. 2003.

[2] Brozović, N., Burbank, D.W., Meigs, A J. Climatic limits on landscape development in the northwestern Himalaya. Science 276, 571-574. 1997.

[3] Schmidt, K.M., Montgomery, D.R. Limits to relief. Science 270, 617-620. 1995.

[4] Riebe, C.S., Kirchner J.W., Granger D.E., Finkel R.C. Minimal climatic control on erosion rates in the Sierra Nevada, California. Geology 29, 447-450. 2001.

[5] Pan J W, Li H B, Jerome V D W, Sun Z M, Pei J L, Laurie B, Si J L. Late Cenozoic morph-tectonic features of the thrust belt in the front of the West Kunlun Mountains. Geological Bulletin of China 26, 10:1368- 1379. (In Chinese with English abstract) 2007.

[6] Sean D. Willett, Mark T. Brandon. On steady states in mountain belts. Geology 30, 2: 175–178. 2002.

[7] David R. Montgomery, Greg Balco, Sean D. Willett. Climate, tectonics, and the morphology of the Andes. Geology 7, 579–582. 2001.

[8] Xiaochi Jin, Jun Wang, Bingwei Chen. Liudong Ren. Cenozoic depositional sequences in the piedmont of the west Kunlun and their paleogeographic and tectonic implications. Journal of Asian Earth Sciences, 21 755–765. 2003.

[9] D. L. Egholm, S. B. Nielsen, V. K. Pedersen, J.-E. Lesemann. Glacial effects limiting mountain height. Nature 460, 884-888. 2009.

[10] J. Taylor Perron, James W. Kirchner, William E. Dietrich. Formation of evenly spaced ridges and valleys. Nature 460, 23. 2009.

[11] Joshua J. Roering, James W. Kirchner, Leonard S. Sklar, William E. Dietrich. Hillslope evolution by nonlinear creep and land sliding: An experimental study. Geology 29, 2: 143–146. 2001.

[12] CliffordS.Riebe,JamesW.Kirchner,Darryl E.Granger, Robert C. Finkel. Minimal climatic control on erosion rates in the Sierra Nevada, California. Geology 29, 5: 447–450. 2001.