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Evidences From Geomorphic Characteristics for the Cenozoic Uplift of the Qinghai - Xizang Plateau

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1 Introduction

Qinghai-Xizang plateau is also named the roof of the world, the third polar of the world, all the mountains 8000m above the sea level on earth are located in this plateau. The uplift of Qinghai-Xizang plateau is one of the most important events in earth history, it is of great significance to the present environment and global change, thus stimulated much study by Geoscientists at home and abroad. By field trip investigation and indoor materials study on Planation surface, paleo-karst landform, drainage system change and deep structure, the authors discovered that Qinghai-Xizang plateau was a unified planation surface with small undulation before uplift from the Eocene to the late Miocene. Qinghai-Xizang plateau was strongly uplifted in the Cenozoic Era.

Planation surface have been widely developed in the Qinghai-Xizang plateau, the authors argue that there are 3 planation surfaces (summit surface, main surface and basin surface) in the Qinghai-Xizang plateau, contradicting to the opinions that there are 2 planation surfaces (Yang et al., 1983; Cui et al., 1997; Pan et al., 2002) or only one planation surface (Shackleton and Chang, 1990). The summit surface is summit of the major mountain ranges on the Qinghai-Xizang Plateau, such as the summit of the Himalayas, the Gangdise, the Kunlun, the Nyenchen Tanglha and the Tanggula Mountains. Most of the summits are about 6000m in elevation except some peaks which are 6500-8000m above the sea level. The main surface is the planation surface universally acknowledged, which are low mountains and hills with small undulation, and divided by gentle valleys and basins, it is representative in the Kunlun-Gangdise area. The main surface is between 5000m and 5500m, and various in elevation from east to west. The basin surface is the gentle valleys and lakes among the summit surfaces and the main surface, most of them are gentle with small discrepancy in elevation except some hillocks.

The authors argue that the Qinghai-Xizang plateau was a unified planation surface with small undulation before uplift. The unified planation surface began to form since the Eocene epoch, with the recession of Paleotethys Ocean. Strong tectonic movements in the end of Miocene epoch disintegrated the unified planation surface, some mountain blocks in Xizang areas were uplifted, forming some graben basins and depression valleys synchronously. The constant uplift of Qinghai-Xizang plateau since the late Miocene epoch about 6.5MaB.P. lead to disintegration of the unified surface, forming 3 planation surfaces with different elevations, named summit surface, main surface and basin surface respectively.

1.1 The Qinghai-Xizang plateau was a unified planation surface before uplift

The sporopollen sampled from the Miocene granule conglomerate in the east Kunlun mountains contains abundant subtroical plants, which reflect a Subtropical environment, it was speculated that the elevation was below 2000m. The hipparion fauna discovered in Jilong basin (Huang, 1979), northwest of the Himalaya mountains, later the age was modified as late Miocene instead of early Pliocene (Qiu, 1987). The hipparion fauna are similar with hipparion faunas discovered in North China plain (Huang, 1979; Yue, 2004), which indicate a similar environment. It was speculated the elevation was 500-1000m, before Qinghai-Xizang plateau uplift. In Jidaguo graben basin near the Yangbajing area, southeast piedmont of Nyenchen Tanglha mountains, there was a sandy gravel stratum unconformity above Paleogene andesite, and unconformity below another sandy gravel stratum. The stratum is of late Miocene, a little younger

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than the Nyenchen Tanglha granite (R.M. Shackleton et al，l990). The forming of the planation surface was ceased simultaneous with the intruding of granite about 10Ma BP. Fossil plants and sporopollen collected from the Lawula fromation in the Mangkang Miocene section (Tao, 1987), represent a subtropical broadleaved deciduous forest environment. It was speculated that there was about 1800m above the sea level, after Himalayan movement the Lawula formation uplifted to 4500, the elevation of main surface (Wu, 1989).

1.2 Paleo -karst landforms evidence

On the Qinghai-Xizang plateau there developed various kinds of paleo-karst landforms, mainly positive landforms, distributed on mountain slopes from 4000m to 5800m above the sea level. The karst landform is closely related to the uplift of Qinghai-Xizang plateau and the disintegration of the planation surface (Cui, 2001). The paleo-karst landforms were formed under long time hot and moist climate when the planation surface was forming before Neocene, it was speculated that the average elevation was about 1500m then. From Pliocene the climate began to deteriorate, and karstification slowed down and terminated in Quaternary when Qinghai-Xizang plateau strongly uplift, the karst landforms began to congelifraction under the puna environment, on some of them there developed horn, cirque, and arête.

1.3 Evidence from valley landform and changes in drainage system

Kunlun col is the modern watershed of the Yangtze River and Kunlun River, an interior river of Qaidam Basin. During Quaternary period Kunlun watershed migrated southward twice, the first time was in the late mid-Pleistocene to the early Epipleistocene, when the Kunlun watershed migrated to the present Kunlun ridge areas; during Epipleistocene to Holocene the watershed migrated southward again, Jingxian valley penetrate through the present Kunlun ridge. The south migration of watershed was due to the imbalance uplift of the Kunlun mountains and the relative descend of the Qaidam Basin compared with the Kunlun mountains.

During early and middle Pleistocene all the drainage systems in Gonghe basin are belong to the Yellow River water system, since mid-Pleistocene Gonghe basin began to uplift instead of descend, caused the changes in drainage system. The Yellow River forms multistage terrace, the imbalance uplift of different blocks and the fold of strata also caused the changes in drainage systems. Chaka basin was separated from Gonghe basin, forming Chaka salt lake, an interior drainage system. Dalianhai pedestal uplift in Gonghe basin since Epipleistocene formed inland Chaka salt lake and Dalianhai interior drainage.

Qinghai crust was stable from the Cretaceous to the Paleogene, in the Pliocene two fault belts appeared which was influenced by the uplift of the Qinghai-Xizang plateau, Qinghai lake region declined violently, forming Qinghai lake basin (Yuan, 1990). In its earlier stage Qinghai Lake was an exorheic lake, it was channeled by the early Daotanghe River with the Yellow River in Gonghe basin. Lacustrine deposit in Qinghai Lake appeared since about 0.5MaB.P., according to Yuan (1990). During the middle Pleistocene and late Pleistocene epoch a strong tectonic movement terminated Gonghe formation and formed Daotanghe River, Chaka salt lake also separated from the Gonghe basin. The Qinghai-Xizang plateau strongly uplifted after this tectonic movement, in Longyangxia area there formed a gorge 800m in depth and multi-stage terrace in the upstream of the Yellow River.

1.4 Deep structure and landform evidence

By the study of seismic wave of Golmud to Tingri, Xu et al. (1996) marked off 5 anisotropic domains, elaborating shear wave anisotropy was closely related to the gigantic landform and mountain ranges on the plateau, the gigantic mountains and faults are situated in the anisotropic transition areas, there is no obvious change on landform at where the anisotropic vector changes slightly. This research probed the relationship of the shear wave anisotropy and landform, providing the relationship between deep structures and landform.

1.5 The main stage of Qinghai-Xizang plateau uplift

From the research above, before strongly uplift Qinghai-Xizang plateau was a unified planation surface with small undulation, the planation surface was formed from the Eocene to the end of Miocene, Qinghai-Xizang plateau was strongly uplifted in Quaternary. The stages of uplift processes are as follows, stage of regression and the forming of continent, uplift incipient stage, strongly uplift stage. The Tethys regressed from Qinghai-Xizang areas in the mid-Miocene, this area began to above the water surface. From Eocene to the mid-Miocene, Qinghai-Xizang areas developed planation surface and karst landform. The second stage of the Himalayan movement formed several tectonic basin, in those basin there deposited strata from the late Miocene to the Pliocene, below the strata there are always coarse gravel layers, it was speculated that Qinghai-Xizang plateau began to uplift but in a small scale. According to the sedimentary facies analysis, Qinghai-Xizang plateau strongly uplifted in the Quaternary period, the third stage of the Himalayan

movement was began from the early Quaternary, the most strongly uplift stage was between Olduvai event and Jaramillo event about 1.3Ma B.P. to the present.

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