雅魯藏布江中游湖相沉積物之隱示及野外初探

The implication of elevated lacustrine sediments in the middle reach of the Yarlung-Tsangpo and Nyang River

黃韶怡[1]、林玉儂[1]、陳于高[1]、賴光胤[1]、鍾令和[1]、
尹功明[2]、劉靜偉[2]、曹忠權[3]

Shao-Yi Huang[1], Yue-Gau[1] Chen, Ling-Ho Chung[1], Kuang-Yin Lai[1], Yu-Nung Lin[1], Jingwei Liu[2], Gong-ming Yin[2] and Zhongquan Cao[3]

1. 台灣大學地質科學研究所
(Department of Geosciences, National Taiwan University)
2. 中国地震局地质研究所地震动力学国家重点实验室
(State Key Laboratory of Earthquake Dynamics，Institute of Geology, China Earthquake Administration.)
3. 西藏地震局
(Seismological Bureau of Tibet Autonomous Region)

摘要

歐亞印度板塊間的碰撞造山帶中，關於氣候、地體抬升以及相關侵蝕作用之間的回饋機制是眾多學者感興趣的話題[*Hartshorn, et al.*, 2002; *Zeitler, et al.*, 2001]。由地形上來觀察，在雅魯藏布江中游區域，分布有交替出現的寬谷和峽谷區。在寬谷區內河流呈辮狀河系輻合交會，河床水力梯度較緩，擁有厚層的沖積沉積物和低位階地。在峽谷區內河道下切很深並呈現曲流河型態，水力梯度陡，河床多爲裸岩出露並擁有高位階地。特別引人注目的是，在這個區域竟然出現湖相沉積物，並且遍佈雅魯藏布江中游以及其支流尼洋河流域。

在尼洋河流域的野外工作中，我們對低位階地裡出露的湖相沉積物組成以及分布進行調查，並採取了年代標本(碳十四以及光螢光樣本)進行相關研究。在低位階地剖面中我們觀察到河相沉積物與發育良好的湖相紋泥層理交替出現，暗示有多次河-湖相環境變遷事件。由前人研究以及實地野外調查的結果，衍生出最直接的疑問是，是否堰塞湖潰堤事件有週期性的特徵？潰堤的年代爲何？而堰塞湖的機制又爲何？

Zhang[*Zhang*, 1998]曾針對此流域奇特的地貌以及沉積物特徵進行探討，認爲上新世以來最新一期的張裂活動是主控本區地形的最大因素；他觀察到寬谷區大部分位於正斷層的下陷側，而峽谷區則位於相對抬升的區塊，由此推論當斷層活動時，河流被阻擋而形成堰塞湖，接著在斷層下降側沉積了厚層的沉積物並發展至辮狀河系；而相對的在抬升區，由於局部性的河流梯度改變和侵蝕基準面下降，強烈的下蝕作用刻劃出今日所見很深的曲流河谷。

然而 Montgomery *et al.*[*Montgomery, et al.*, 2004]提出另一種新觀點，從湖相沉積物的分布範圍、高度、沉積相以及碳十四年代的數據，他推論這些厚層的湖相沉積物肇因於冰川所造成的堰塞湖，一次約在 9,000 到 10,000 年之間，範圍可達加查地區，並造成 3500-3600 公尺之階地；較年輕的一次則在 1,200 到 1,700 年之間，湖面範圍約至朗縣地區，與 3100 公尺之階地相關。Montgomery 認爲此地的冰川受到季風影響，在補足水氣時冰川增長，因此導致冰川堰塞湖的誕生。並進一步由相關的水力公式推算，當堰塞湖潰堤時，其水量勢必造成此區域的大洪水事件。雖然此計算出的水量未必是世界上已記錄到的最大洪水量，但此洪水將被局限於既深又狹窄的雅魯藏布江河谷之中，因此所造成的單位水流功率(unit stream power)將遠遠大於目前已知的任何洪水事件。

重複發生的洪水在此區域將會造成怎樣的衝擊？是否會造成地表上最猛烈的侵蝕作用，進而影響到抬升速率與剝蝕作用的交互關係？而堰塞湖潰堤的活動年代是否與季風的消長有關亦或是構造成因？由我們建立的地層柱可知，在低位階地剖面中至少有兩次湖相沉積時期，從較底部的湖相沉積物中所得到的碳十四年代爲大於五萬年，遠大於前人所發表的數據，暗示了河湖相變遷的故事可能較前人推想的更爲複雜。爲了釐清湖相沉積物在此區域扮演的角色，我們將需要更多年代上的證據以及更周全的野外調查。

The feedback mechanism among climate, crustal uplift and related erosion processes in the orogenic belt is one of the most discussed topics in recent decays, especially in the collisional margin of Eurasian Plate and Indian Plate [*Hartshorn, et al.*, 2002; *Zeitler, et al.*, 2001]. From the perspective of fluvial landform, the middle reaches of the Yarlung-Tsangpo consist of sections with alternating wide valleys and gorges [*Zhang*, 1998]. These two fluvial landforms exhibit distinctly different characteristics. The wide valley sections generate braided and anastomosing channels with gentle slope. Thick alluvial sediments cover the wide valley sections and most terraces found are low. On the contrast, the gorge sections generate single straight and deeply entrenched meandering channels with steep slope. The channels in the gorge sections are mostly bedrock rivers and high terraces are found. Notably, terraces with lacustrine strata appear along the Yarlung-Tsangpo and Nyang River, the tributary of the Yarlung-Tsangpo.

We surveyed the drainage of Nyang River and investigated the outcrops of lacustrine strata in the lower terrace and established the stratigraphic column. Woods and peat samples were collected for radiocarbon dating and sand from alluvial terraces for optical stimulated luminescence (OSL). Based on our observation, the alluvial strata and lacustrine ones occur alternatively and well developed varve layers were exposed in the lacustrine sections. The appearance of alluvial and lacustrine strata suggests that there were multiple episodes of environmental changes. According to previous studies and our field observation, the questions come to us that did the breakout of the dammed lake strike this drainage repeatedly? What is the mechanism of the dammed lakes, were the paleolakes dammed by monsoon driven valley glacier or tectonic structure [*Zhang*, 1998]? And, when did it occur?

From the stratigraphic column, there are at least two episodes of paleolakes recorded in the lower terrace. The age of the wood collected from the bottom of the profile is dated to over 50 ka, which is far older than previous report (1200 – 1700 yrBP, Montgomery, *et al*., 2004). These results suggest that the scenario of paleolake breakout should be much more complex. Further evidence from age dating and field survey will be needed to gain more understanding toward the role of the lacustrine sediment in this particular drainage.

References

Hartshorn, K., et al. (2002), Climate-Driven Bedrock Incision in an Active Mountain Belt, *Science*, *297*, 2036 - 2038.

Montgomery, D. R., et al. (2004), Evidence for Holocene megafloods down the Tsangpo River gorge, southeastern Tibet, *Quaternary Research*, *62*, 201-207.

Zeitler, P. K., et al. (2001), Erosion, Himalayan Geodynamics, and the Geomorphology of Metamorphism, *GSA Today*, *11*, 4-9.

Zhang, D. D. (1998), Geomorphological problems of the middle reaches of the Tsangpo River, Tibet, *Earth Surface Processes and Landforms*, *23*, 889-903.