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A visionary geomorphologist and glaciologist: Professor Jijun Li on his eightieth birthday

This special issue of *Quaternary Research* is dedicated to the career of Professor Jijun Li (Fig. 1), a prominent scholar and educator who has had a profound influence on our understanding of Quaternary geology in China through his own research, his development of a community of like-minded scientists centered around his decades-long program at Lanzhou University, and his inspirational efforts to link Eastern and Western scientific communities once that became politically feasible in the 1970s. Jijun Li was born in October 1933 in Pengzhou City, in Sichuan Province of China, and worked nearly 60 years at the Lanzhou University teaching, conducting research and, most importantly, inspiring new generations of students. During his career he made broad and significant contributions to Lanzhou University and to the global scientific community. This biographical sketch introduces Professor Li's exceptional achievements in geomorphology, glaciology, and Quaternary science. From his early days as a young geographer, he grew to become a world-leading Earth scientist with a research focus on the formation of the Tibetan Plateau (TP) and its social and environmental impacts.

Professor Li has been widely recognized for his significant contributions to science and his singular efforts on behalf of many national and international organizations (Qin et al., 2013). In past decades, he served as head of the Department of Geography at Lanzhou University, chairman of the Board of Directors of the Gansu Geographical Society, chairman of the Geomorphologic and Quaternary Geology Specialty Committee of the China Geographical Society, vice chairman of the Supervising Committee of Geographical Education at the Ministry of Education of China, vice chairman of the China Geographical Society, and chief scientist of the Research Center of Earth and Environmental Sciences, Lanzhou. He was appointed to the Academic Degree Committee by the State Council of People's Republic of China to organize the National Geography Subcommittee, charged with formulating national academic degree policy.

Professor Li has been awarded numerous national awards in recognition of his teaching and research achievements, including the national Outstanding Young Scientist Award, the first-prize Award for Advancing Science by the Ministry of Education, the first-prize Award for Fundamental Scientific Study by the Chinese Academy of Sciences, and the first prize of the national Natural Science Award. He was also presented with an Outstanding Contribution Award for his glaciology and geocryology field investigation, and the Chu Kochen Medal for the field work achievements (Fig. 2).

Professor Li experienced many political obstacles in his journey of professional teaching and scientific research. From 1959 to 1961 and from 1965 to 1972, Professor Li was essentially isolated from teaching and scientific research, and very often even from his family, because his dedication to science made him appear indifferent to the then so-called “national mainstream” and the Cultural Revolution movement. In his later career, following the end of the Cultural Revolution, he was able to overcome these externally imposed obstacles and realize his potential (Fig. 3).

Academic achievements

Education and career

Professor Li graduated from the Department of Geography at Nanjing University in 1956 and was admitted for graduate studies in the Department of Geography at Lanzhou University under the supervision of Professor Deji Wang, a well-known geomorphologist who returned to China after earning his Ph.D. in Germany. Unfortunately, the entire graduate program was soon terminated, mainly for political reasons. Nevertheless, the next year, 1957, Professor Li was hired by the Department of Geography as a young faculty member. Following years of political turmoil in China, Li was promoted to associate professor in 1978, to full professor in 1983, and appointed as head of the Department of Geography in 1984. In 1991 he was elected to membership in the Chinese Academy of Sciences.

In 1958 Professor Li participated in an expedition led by Professor Yafeng Shi to the Qilian Mountains of western China. This was a watershed moment in his career, and from then on glacial studies formed a central focus of his research. The purpose of the expedition was to study how the local farmers utilized alpine glacier and snow meltwater resources for irrigation of the oases along the ancient Silk Road. Professor Li was soon placed in charge of a team that investigated glaciers in the upper reaches of the Heihe River Basin. The next year, Professor Li led another team to investigate snow cover and glaciers along the Shule Nanshan–Hala Lake area. Those two years of field experience led him to believe that under extreme continental climate conditions an alpine tundra zone exists between the tree line and modern glacial areas, but not under marine climate conditions at the same altitudes (Li, 1983). Unfortunately, research was largely suspended between the mid-1960s and the early 1970s due to the Cultural Revolution.

Glacial studies

At the end of the Cultural Revolution, from 1973 to 1976, Professor Li participated in the “Comprehensive Scientific Expedition of the Tibetan Plateau” organized by the Chinese Academy of Sciences. Again, he led the Glacier Team. He and his team conducted intensive field investigations on glaciers over the TP for the next decade. As part of these investigations, Professor Li systematically studied the geographical conditions necessary for glacier development, glacier distribution, glacier characteristics, processes of snow transformation into ice, glacier dynamics and movement, and changes in glaciers in western China. He identified distinctive climatic conditions and geomorphologic processes for the two different glacier types. This research was later published in a comprehensive monograph entitled “Glaciers in Tibet” (Li, 1986).

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Figure 1. Professor Jijun Li.

At this same time, Professor Li and his collaborators conducted comprehensive studies of earlier Quaternary glaciations in China and explored the relationship between glacial periods and the uplift of the TP. They concluded that glaciers in China were mainly developed along high mountain ridges, and that there never was a plateau-wide ice sheet on the TP, even during the most glacial periods of the Pleistocene. Their findings were favorably recognized by the national and international scientific communities.

In the 1980s, Professor Li began investigating Quaternary glaciations in eastern China. Decades earlier, in the 1920s, Professor Siguang Li and his followers had proposed that glaciers had developed during the Quaternary from Daxing'an Ling (Ling means 'mountain ridges' in Chinese) in the north to Hainan Island in the south, including the Lu Shan (Shan means 'mountain' in Chinese) and Huang Shan areas in eastern China.

Although there had been substantial debate about the Quaternary glacial deposits in eastern China, the key issues had remained unresolved for over half a century. After more than four years of comprehensive studies of putative Quaternary glacial deposits in eastern China, Professor Li and his colleagues concluded that only in a few isolated areas were they actually glacial in origin. These areas were in Taibai Shan in Shanxi, Gao Shan in Taiwan, and Changbai Shan in Jilin. The majority of previously proposed glaciated areas were actually unglaciated, including Lu Shan (Li et al., 1983; Shi et al., 1989). At this time, Professor Li and his colleagues associated the uplift of the TP with environmental evolution in eastern China. This study became a milestone for Quaternary glaciation studies in China.

Loess, the Monsoon Triangle, and orbital cycles

After systematic studies of the distribution of loess in the Chinese Loess Plateau and red soils in southern China, Professor Li proposed the presence of a "Monsoon Triangle Region" that had experienced dramatic climatic shifts associated with glacial and interglacial alternations (Li et al., 1988). During glacial periods, the Monsoon Triangle Region was dominated by cold and dry winter monsoons, with the predominant ecological environment consisting of steppes, whereas during interglacial periods, this region was dominated by warm and moist summer monsoons and characterized by deciduous and coniferous forest ecosystems. The Monsoon Triangle Region is bounded by lines from the Yangtze River delta and the Yalu River in the east to Lanzhou in the west. It covers not only the Loess Plateau, but also the North China Plain and the drainage basin of the Yellow River.

Professor Li was among of the first to find evidence of orbital cycles from Chinese loess and to compare those cycles with ice-core results

Figure 2. Professor Li and his wife, Professor Junjie Zhu, during field investigation at Wuhai, Inner Mongolia, China in 1999 (photo by Zhijun Zhao).

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Figure 3. Professor Li examining the Miocene stratigraphy at Wangpuliang, Qingan county of Gansu Province, in 2004.

(Burbank and Li, 1985). These results played a key role in helping the geological community recognize that Chinese loess is an effective paleoclimatic archive, and led to three decades of subsequent studies of the Loess Plateau.

Terraces of the Yellow River

Professor Li pioneered the use of the elevations of lights of terraces along the Yellow River and the Chinese Loess Plateau to infer Asian paleoclimatic changes, their relationship with the uplift of the TP, and global climatic changes and insolation forcing (Li et al., 1997). Using field investigation, paleomagnetism and fission-track dating, Professor Li and his research group successfully recognized and dated seven terraces in the upper reaches of the Yellow River. Based on these results, Li concluded that (1) the Yellow River reached its current configuration at 1.7 Ma; (2) the seven terraces were formed mainly because of the episodic uplift of the TP, with help from increased river incision associated with orbital-timescale climatic changes; and (3) the drainage area of the Yellow River itself was greatly increased by progressive headward stream erosion into the TP, demonstrated by the younging of terrace ages upstream. The importance of Li's systematic studies of these terraces is widely recognized by the international geomorphology community.

Signature research—an uplift model for the Tibetan Plateau

Professor Li's signature research was on the TP, the highest plateau in the world. It not only strongly affects regional and global climate, but also holds the key to understanding those aspects of continent–continent collision that have been difficult to explain by modern plate tectonic theory. After extensive field investigations over several decades, Professor Li proposed a chronology for the uplift of the TP (Li et al., 1979; Li, 1991; Li and Fang, 1998). In his model, there were three main phases ('Tibetan Movement'): phase A at 3.6 Ma, phase B at 2.5 Ma, and phase C at 1.7 Ma. Later, two younger phases of uplift were added to this original model: the 'Kunlun–Huanghe Movement' at ca. 1.1–0.6 Ma, which raised the entire plateau above the snow line and changed the dominant climatic periodicity from 40 to 100 ka; and the 'Gonghe Movement', which raised the TP to its current elevation and initiated modern climatic conditions there. This five-phase model is consistent with stratigraphic, geomorphologic, and paleoenvironmental evidence.

Although some recent studies have indicated that the TP may have gained its highest elevation during the Eocene and the Miocene, Professor Li argued that elevation gains associated with the two early phases of uplift were subsequently eliminated by planation, and that it was the Pliocene–Pleistocene uplift that produced the current configuration of the TP. The hypothesis of the uplift model is summarized by Li et al. (2014).

Longzhong Basin

Professor Li's research includes the stratigraphy and dating of the Longzhong Basin at Tianshui in the northeastern TP (Li et al., 2007). Neogene strata rich in mammalian fossils are widely distributed in the basin. *Hipparion weihoense*, a typical member of the late Middle Miocene Bahean Stage, was recently excavated at Yaodian near Tianshui. Because of the importance of the Bahean Stage in mammalian evolution and its potential to record environmental change, Professor Li and his colleagues named the stratigraphy the 'Yaodian Formation'. It is correlated with the Bahe Formation at Lantian, Shaanxi. Professor Li and his colleagues conducted high-resolution paleomagnetic dating of the section, and found that the Yaodian Formation covered the period 11.67–7.43 Ma, with the site bearing *H. weihoense* at ca. 10.54–10.30 Ma. This work provided the first magnetostratigraphic chronology for the Bahean Stage. The Yaodian Formation consists of fluvial channel deposits at the bottom (11.67–10.40 Ma), floodplain deposits in the middle (10.40–9.23 Ma), and shallow lake sediments at the top (9.23–7.43 Ma). This upward-fining sequence suggested to Professor Li that the relief in nearby mountain ranges, such as West Qinling to the south and Huajia Ling to the north, was being reduced by erosion, and the fluvial transport capacity along with it. Finally, the drainage system was disintegrated and was replaced with broad, shallow lakes in which only fine sediments were deposited. Sedimentation evidence in this region thus indicates a late stage of planation-surface development, suggesting tectonic quiescence during this period. Li hypothesized that the current relief of the Qinling Mountains did not form until the Late Pliocene, when it was associated with the intensive uplift of the TP.

Western China

In the six decades Professor Li spent in Lanzhou he paid special attention to human geography in arid and semi-arid regions in addition to his studies of physical geography. One focus of these studies was the economic development of western China. To facilitate this he promoted the establishment of the branch of the Arid and Semiarid Geography Society of Western China under the China Geography Society, and the Research Center for Resource and Environmental Science in

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Western China. He also suggested re-establishing the "Silk Road" to enhance cultural exchange and economic development with Central Asian countries.

Summary remarks

Educator

Although Professor Li is well-known for his scientific achievements, perhaps his most significant contribution has been in education. Younger generations have benefited from his thorough and effective organizing of research teams, which he used to train young scientists and graduate students as he himself had been trained in the 1950s. During the mid-1970s, Professor Li, together with Professor Yafeng Shi and other colleagues from the former Lanzhou Institute of Glaciology and Geocryology, realized that there was a shortage of young glaciologists and permafrost scientists in China. To redress this shortage, professors Li and Shi jointly initiated an undergraduate program on glaciology and geocryology at the Department of Geography at Lanzhou University. Although the undergraduate program only lasted six years, there were more than two dozen graduates from the program, many of whom are still active in the community of cold-regions science and engineering.

During his active career Professor Li educated more than 100 graduate students. Two of his former students have been elected as members of the Chinese Academy of Sciences, and several other candidates are in line for this recognition. Many former students now play key roles in national and international research activities and programs.

International exchanges

Professor Li consistently promoted international exchange programs during his tenure at the Department of Geography at Lanzhou University, to the benefit of students there. Thanks to China's reform and its 'open-up' policy of 1978, Professor Li and his colleagues were able to visit the U. K., France, U. S. and Switzerland. Two years later he invited geomorphologist Edward Derbyshire from the U. K. to visit Lanzhou University, to teach a three-month course on glacial deposits and to join a field survey to Lu Shan in eastern China, Qilian Shan and the source region of the Urumqi River in the Tien Shan of western China. Invited by Professor Steven Porter from the University of Washington, Li visited the Quaternary Research Center in Seattle from 1984 to 1985. Professor Li also participated in field expeditions in the 1990s and early 2000s in the European Alps, the Ob River basin in Siberia, and many Asian mountain ranges outside of China. He always required that his students have a solid background in geosciences, and that they obtain first-hand data and information through field investigation and in-situ measurements.

Professor Li encouraged international collaborations at Lanzhou University from the early 1990s through the early 2000s. These included work with colleagues from the Department of Geography of the Royal Holloway University of London and from the Free University of Berlin, and field expeditions on Quaternary glacial studies. He also organized several national and international symposia. Professor Li chaired the working group on "Glacial Deposits and Environments over the Asian Monsoonal Regions" of the International Union for Quaternary Science (INQUA) from 1992 to 2002.

Communicator

Professor Li has devoted much of his life to scientific outreach and knowledge transfer. He communicates effectively with whatever audience he is facing: the general public, politicians, policy makers, or college students. As an advisor of undergraduate and graduate student he emphasizes not only excellence in their academic research, but also their need to be exemplary citizens. He asked his students to be "a scholar after the style of the gentleman and not that of a flunky." Professor Li embodies these high standards, and acts by example as a role model to guide his students to do the same. Because of his achievements in science and education, particularly in geomorphology, glaciology and Quaternary science, Professor Jijun Li's contribution will benefit generations to come.

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