

A STUDY ON NATURAL ENVIRONMENT OF  
SOURCE REGION OF THE CHANGJIANG RIVER

Editors by  
Sun Guanyou Tang Bangxing

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孙广友 唐邦兴 主 编



科学出版社

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**科 学 出 版 社**

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## 内 容 简 介

本书系 1986 年长江漂流探险和河源区科学考察的研究成果。全书共收入论文 16 篇。它从不同的层次和角度对长江河源区的地貌、气候、水文、土壤、冰川、湿地与泥炭、生物、自然灾害等进行了系统分析和综合论述,对长江正源及源区现代自然环境演化趋势进行了探讨,具有较高的学术价值。

本书可供青藏高原研究者、地球科学工作者和大专院校师生参考。

## 长江河源区自然环境研究

主 编 孙广友 唐邦兴

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為長江漂流綜合考察成功誌慶

球渡篇賢  
襄開新前  
冠等賦賽  
險楚  
江萬流二  
長辛源清  
流千攷一  
漂綜

盧嘉錫

一九八六年十一月

中国科学院院长卢嘉锡的题词(原刊《科学报》1986年11月2日)

谨以此书献给中国长江科学  
考察漂流探险队全体队员和  
给予帮助的各族人士

作者

## 序

源出青藏高原腹地的长江,劈山凿岭,跌落三大阶梯,浩浩荡荡,直入东海。长江流域囊括 180 万平方公里的国土,哺育 3 亿之众的人口,而流域内自然资源极为丰富,这些资源的开发对中华的振兴意义至关重大。因之,开发长江已是当代重大课题。

然开发长江必先认识长江,多年来众多科技人员为之做出了卓著贡献。但尚有许多问题仍悬而未决,如长江正源究竟在何处,凡 2400 余年来未得定论;长江源区自然环境如何,亦是高原研究的薄弱环节。可喜的是,在 1986 年举行的长江科学考察漂流探险中,一批中青年科技工作者深入江源漂流考察,获得了丰硕成果。

更可喜的是,他们并未浅尝辄止。漂流探险后的数年来,继续潜心研究,终于完成这部论文集。集中的 16 篇论文,从地貌结构、古气候变化、冰川发育、沼泽分布以及生态环境等不同的侧面分析了长江河源区的自然环境。文集中包括珍贵的第一手资料和地学的新发现,这对过去进行的青藏高原综合考察也是有益的补遗。这些成果是作者们冒着生命危险,顽强拼搏,历尽艰辛得来。因此,不仅文集的科学内容诚然可贵,而且文集所体现的探索精神价值更高。

我衷心祝贺这本文集的出版。



1991 年 11 月 29 日

# 前言

改革开放的大好形势,使中华民族迸发出空前的创造力,80年代中期,终于发出了向长江挑战的宣言:中国人要首漂长江。一时间,一批批有志青年或来自长城内外,或来自大江两岸,汇聚于天府之国。一个由四川省地理学会,四川日报,以及人民日报、光明日报和经济日报驻川记者站等联合动议,并得到四川省人民政府和中国科学院大力支持的中国长江科学考察漂流探险队于1986年4月21日在成都宣告成立。她肩负着全程无动力漂流长江和对长江进行科学考察的双重使命。

伟大的长江是世界第三大河,从冰封雪覆的青藏高原到波澜壮阔的东海之滨,全长约6300公里,与黄河并誉为中华民族的摇篮,是我们的母亲河。但长江又是世界最惊险的河流,总落差达4500多米,金沙江惊涛裂岸,峡谷擎天,礁石林立,险滩密布。多少年来,中外漂流勇士或罹难于狂涛恶浪,或兴叹于激流危岸。长江,以她冲决一切永不屈服的气概维护着唯一未被征服的尊严。

然而,正是长江哺育的炎黄子孙,高唱着“你从雪山走来……你从远古走来”的颂歌,开始了漂流长江的艰苦历程,他们以献出5位勇士的生命为代价,终于完成了全程漂流长江的历史使命。再一次向全世界显示出中华民族不畏艰险,顽强拼搏的崇高品格和伟大精神,再现了我们的民族之魂。

在漂流勇士们闯险滩的同时,科考队员在人迹罕至的长江河源区开展了生态环境综合考察。但他们不是一般含义的考察,而是科学探险。他们随队漂流了沱沱河,而后又在无急救设备和随队医生的情况下,翻越海拔5500m的唐古拉山东段,轻装进入当曲无人区。波涛汹涌的冰水河未能挡住他们的进程,令人胆寒的高原雷暴也没能使他们退缩。为了获取科学资料,他们完全置生死于度外。

无畏的探险精神和执着的科学追求,终于换来丰硕的收获——这本文集包含着大量的科学数据和多项重要的科学发现。

文集第一篇“长江正源研究”,根据主导指标与综合分析相结合的原则,从河流长度对比、流域面积与流量对比,及其他因素对比进行了综合分析,表明当曲在河长、流量和流域面积三个重要指标中均占优势甚至绝对优势;而沱沱河只在河流走向和河源地势高度这种非主导指标上占有优势。据此,确定了当曲为长江正源,长期以来把沱沱河做为长江正源是缺乏科学根据的。

以当曲为长江正源重新订正长江的长度,当曲长为353.1km,而通天河以下仍采用原来数据,则长江全长为6280km,仍占世界第三位。

“长江源流遥感分析与河长量测”一文,通过高精密度量测得出长江三条源流的准确长度:当曲为 $353.13 \pm 0.116$ km,沱沱河为 $346.28 \pm 0.168$ km,楚玛尔河为518.50km。表明当曲应是正源,源头位置在扎西君高原的泉成湖泊。

“长江上游泥石流灾害及防治对策”一文,首次分析了本区泥石流灾害具有规模大,频数高,危害大等特点,指出构造带和地震带上泥石流密集,并且具有日益严重的趋势,提出了综合治理对策。

“长江河源区的现代冰川”一文,统计出 625 条冰川,面积 1 168. 18km<sup>2</sup>,冰储量  $9.83 \times 10^{10} \text{m}^3$ ,以山谷冰川和冰斗冰川为主。在总体退缩背景下,有少数冰川在前进。

“长江河源区冰雪水的氢氧同位素含量和水化学特征”一文,计算了氢氧同位素含量,分析了冰雪水化学特征:矿化度低,平均为 11. 70mg/l, pH 值为 6. 60,属于  $\text{Cl}^{\text{Mg}}$  和  $\text{Cl}^{\text{Ca}}$  型。河水矿化度稍高,都是可饮用淡水。

“长江河源区水化学基本特征的研究”一文的结论是:地表水与地下水的 pH 值均 > 7,一般在 7. 5—8. 2。东部区的矿化度较西部区低,沱沱河流域水化学类型复杂,水质咸化明显。

“长江渡口以上水化学”一文,对长江上游的水化学做了系统分析,指出从源头到渡口,矿化度沿程减少,水质变好。以巴塘为界,上游为硬水,下游为软水。水土流失使水质受到影响。

“长江河源区南部主要土壤类型及分布规律”一文,阐述了区内土壤形成条件,气候严寒干燥,冰缘作用强烈,成土母质粗骨,植被积累有机质强度较低。成土过程具有短暂性,有机质含量低,钙积作用强等特点。土壤类型主要有寒漠土、草毡土、莎嘎土和沼泽土四类。

“当曲与沱沱河流域土壤微量元素的自然含量及分布特征”一文,指出不同母质的草毡土微量元素的丰度不同。区内四种主要土壤的微量元素具有草毡土 > 沼泽土 > 莎嘎土 > 寒漠土趋势。Cu、Co 等在表层富集;Sr、Ba 在淀积层富集;微量元素总量低于世界土壤平均值。

“长江河源区冰缘环境沼泽的研究”一文,指出长江河源区冰缘环境的高原沼泽是本次发现的中国面积最大的沼泽,也是世界上最大的高原沼泽。冰缘作用是最主要的控制因素,低温有利于泥炭积累,所以泥炭层普遍发育,并有冻胀泥炭丘等特殊类型。

“长江河源区的鱼类及其区系分析”一文,首次系统全面地调查了该区鱼类的结构,提出了区系划分,并分析了鱼类的形成演化过程,填补了江源区鱼类研究的空白。

“长江河源区的泥炭地与晚全新世以来的环境变化”一文,阐述了该区是世界上最大的高原泥炭地,总面积达 8000km<sup>2</sup>,最高海拔为 5300m,最大泥炭厚度为 1. 8m。<sup>14</sup>C 年龄为  $2670 \pm 70 \text{a. B. P.}$ ,属于晚全新世堆积。近期环境趋向干旱。

“当曲与沱沱河汇口段河流断面的水文特征”一文,依据实测资料测绘了两河的断面图,测到了流量数据,当曲流量较沱沱河大 6. 5 倍,表明当曲应是长江正源。

“长江河源区自然环境及近期演化趋势”一文,综合分析了江源区湖泊、沼泽、土地沙化、冻土发育等因素,指出长江河源区的环境正在趋向干旱,而这不是受人类重大干扰下发生的,证明全球正在变暖。

“青海省长江流域陆生脊椎动物”一文详列了该区的脊椎动物名录,是难得的宝贵科

学资料。

“长江河源当曲河口人类石器的新发现及其意义”一文,首次报道了在当曲无人区发现了人类石器,对探索古人类演化和环境变迁都有参考价值。

关于这本集子科学水准的高低,唯读者是权威。我只想说,长江上的科学考察和漂流探险从两个方面实践着同一的人生价值——探索与创新。只有这崇高的精神才有资格与斯年不息的长江波涛同在。

最后,谨让我代表本书全体作者——科考分队同仁,向给予学术指导的刘东生院士、孙鸿烈院士;给予热情帮助的漂流队战友,社会各界人士和藏胞,致以衷心谢意。

侯惠仁

中国科学院成都分院党组书记

中国长江科学考察漂流探险总指挥长

1991年5月30日

## PREFACE

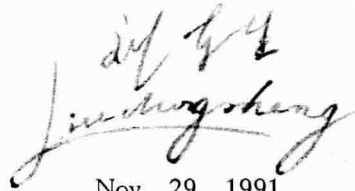
The Changjiang River, coming from the center of the Qinghai - Xizang Plateau, cutting mountains and hills and falling from three great terraces of landform of China flows mightily into the East Sea.

She has large land and population in her valley, she also has rich natural resoulces in her basin. Therefore, the development of the changjiang river will be a great signification to Chinese economic.

But we must understand the Changjiang River before developing it. Although the scientists study the Changjiang River for a long time, but there are still lot of problems on the Changjiang River. For example, where is the main source of the Changjiang River? No people has given a incontestable conclusion since 2400 years. How about the natual environment in the source region of the Changjiang River? That is a weak sical link of the plateau study. I am glad that some scientists, a group of middle and young men, got answers during the Scientific - Drifting Explore of the Changjiang River in 1986.

I am also glad that they did not stop the work and they have studied the problems of the Changjiang River for ten years since 1986. They finally finishsd this symposium including 16 papers. The papers discussed various problems on the source region of the Changjiang River; The main source; The environment change; The ecosystem; The glacier; The wetland and peatland; the fish , etc. The lot of valuable materals and new discoveries also has been included in the book. The results wiped a gap and they are profitable supplement to the investigation of the Qinghai - Xizang Plateau. These results have been goten to pay the life price. Therefore, the book not only has the valuable subjects but also has a high price in the research spirit.

I celebrate that the symposium can be published.



Nov. 29, 1991.

## FOREWORD

In the middle of the 1980s, at the encouragement of policy of the reform and open to the world in China, the Chinese people turn out to be the more creative than ever before, which lead to the epoch-making proclamation widely known to the world that of the Chinese would, for first time in human history, drift down on the Changjiang River. With the hearing news, the group and group of ambitious young people from all over the country converged in the capital city of Sichuan Province as their correspondence to the challenge. At the same time, a motion was first put forward by Sichuan Geography Association, the Sichuan Daily, the People's Daily, the Guangming Daily and the Correspondents station of Sichuan Province from the Economic Daily, with the forceful support of the Sichuan Provincial Government and the Chinese Academy of Sciences, a team of both drifting and scientific research on April 21, 1986 had been engaged in scientific explorations and drifting down on the Changjiang by human power only.

Changjiang River is considered to be the third in the length in the world, which flow course is from the snow-icecovered Qinghai-Xizang (Tibet) Plateau to the East China Sea, with the total length of 6300 km. Just as the Yellow River, the Changjiang River is also the cradle of the Chinese people, regarded as our mother river. On the other hand, it is also the most thrilling river in the world, for its total drop height is about 4500m. In one section known as Jinsha River, which is a part of upstream of the Changjiang River, terrible surges and foams on top of the hazard rapids and shoals between deep valleys can be seen anywhere, not to say anything about mountain peaks rising high into the sky, reefs like forests hidden thick beneath debris of the stream. Hazards in drifting down the stream are not only caused by the violent surges and foams out resulted in rocks as obstacles under the seemingly quiet water somewhere. For many years, both Chinese and foreigners who had carried out to drift down the river either lost their lives in the unharnessing waves or helplessly sighed when facing the river so that the river had won the well-known fame for its untamable glory up till that time.

However, it was the Chinese who feeded up by the Changjiang River for first time, determined to start their hard and rough course, with the ode of Changjiang River accompanied them: "You are coming from the snow mountains...you, the river, comes down from the far ancient". At last, they achieved their historic success as the lost of five lives on the expedition of the river, showed their high moral character and great spirit of Chinese nation to the world, They do not fear any hardship to wrestle tenaciously, express our national soul again.

During the course of drifting down the river, the researchers made comprehensive

surveys on the ecological environment in the untraveled source region of the Changjiang River. This is unbelievably tough scientific exploration rather than generally mean researches. Those scientific explorers, together with the drifting adventurers, had drifted through the whole course of the river called the Tuotuo, after that, they went in the depopulated zone called Dam River after having crossed over the east range of Tangula Mountains 5500m high. This was done under the condition of having no first-aid equipment and doctors with them. In order to obtain firsthand materials, never did they consider themselves during the time they overcame difficulties while facing the turbulent ice-water stream and being exposed to the horrible plateau and thunder storms.

At last, by such a great achievement-this symposium, containing a great amount of scientific data and several significant discoveries were obtained by that they have been studying for a long time and do not fear any difficult.

Based on the principle of combining dominant index with synthetic analysis, the first essay in the book, entitled as "Research on the Main Source of the Changjiang River" showed that, by comparing the river length, the basin area and the discharge measurement, the Dam River predominates over the other river called Tuotuo River in the index of the river length, discharge measurement and hydrographic basin area, while the Tuotuo River is considered to be in the dominant position in the river course direction and the altitude of the river source so that the people concluded that taking the Tuotuo River as the main source of the Changjiang River showed insufficient scientific basis and convinced that the Dam River should be the main source of Changjiang River.

Taking the Dam River as the main source of the Changjiang River which is 353.1km and the length from the Tongtian River to the Changjiang River mouth as its original data makes the total length of the Changjiang River, which is 6280km.

"Remote sensing analysis of the Changjiang River source flow and the river length measurement" gives the accurate length of the three source flows by high accurate measuring: Dam River is  $353.13 \pm 0.116\text{km}$ , Tuotuo River is  $346.28 \pm 0.168\text{km}$ , while Churema River is 318.50km. These figures show that the Dam River is the main source whose origin is from rising spring formed a lake in the Zhaxijun Plateau.

"The calamity of mud - rock flow and prevention and control in the upper reaches of the Changjiang River", for the first time, analysed calamities caused by the regional mud-rock flows which are characterized by their large scale, high frequency and great damages. It also points out that there are increasingly denser mud-rock flows on the tectonic zone and the seismic zone. The essay also gives ways of how to harness the disasters.

According to statistics of "modern glaciers in the source region of the Changjiang River", there are 625 glaciers in that region, mainly made up of mountains and cirque glaciers, covering the area about  $1168.18\text{km}^2$  with the ice storage of  $9.83 \times 10^{10} \text{m}^3$ . In general, the glaciers in this area are in retrogress except for that a few of them are in

progress.

"Content of oxyhydrogen isotopes in the ice-snow water and hydrochemical Characteristics in the source region of the Changjiang River" gives the calculation of the oxyhydrogen isotopes and the analysis of the snow-ice water, which shows that the average mineralizations is about 11.70mg/l, with the pH value of 6.60, belonging to  $C_I^{Mg}$  and  $C_I^{Ca}$  type. The calculation also showed that the mineralization of the river water is so a little high that it is possible for drinking.

The conclusions drawn by "Research of the basic hydrochemical characteristics of the Changjiang River source region" is that the pH value of the surface water and the groundwater is  $>7$ . Though the average value pH is from 7.5 to 8.2, the conclusions also explained that the level of mineralization of the water in the east region is lower than that of the west. Analysis showed that the hydrochemical characteristics of the water in the Tuotuo basin area is so complicated that it is obvious salty.

The hydrochemistry in the upper reaches to Dukou of the Changjiang River, which makes the detailed analysis on the upstream of the Changjiang River, points out that the water quality begins to turn better gradually from the source flow to the place called Dukou because the level of mineralization decreases. Taking the place called Batang as the boundary, the water in the upstream belongs to hard water, while it belongs to soft water in the downstream in lower part. It is resulted from soil erosion that affects the water quality.

In the article entitled as "Main types of soil and its distribution in the south region of the Changjiang River source", the writer elaborated the soil formation conditions, such as cold and dry climate, violent periglacial reactions, rough parent materials of the soil formation, lower intensity of the organic matter accumulation, short time of soil formation process, low contents of organism, as well as strong calcification accumulating actions, etc. The soil is roughly divided into frigo-desert soil, meadow soil, saga soil and marsh soil.

The main idea of "content and distribution of trace elements in the natural soils of Dam River and Tuotuo River area" is that meadow soil with different materials have different trace element abundance in. It concludes that the relations of containing trace elements in the four main soils is shown as: meadow soil, marsh soil, saga soil and frigo-desert soil. Cu and Co are abundant in the top soil, while Sr and Ba are abundant in the illuvium. It also showed that the total amount of trace element is lower than the average value of the soil in the world.

Study on mire in periglacial environment in the Changjiang River source region point out that the plateau marsh in the periglacial environment in the river source area is the largest mire discovered in both China and all over the world. According to the material, the periglacial is the important control factor, where the low temperature is suitable for peat accumulation so that the peat lay has widely developed. Not only this, there is also special types of peat hillock in this area.

"Classifications and regional system of fish in the source region of Changjiang River" is

written based on the overall investigation on the fish patterns in the area. It puts forward the method on fish family discriminations and analyses the evolution course of the fishes, and this fills up the gaps in the fish research in the river source area.

"Peatland and environment change since late holocene in the source region of the Changjiang River" described that this region is the largest plateau peatland in the world, covering 8000km<sup>2</sup> of the total area and 5300m of the highest altitude and the thickest peat of 1.8m. The <sup>14</sup>C age is 2670 ± 70a.B.P, belonging to Early Holocene. The condition of environment tends to be drought.

"On the hydrological characteristic in the convergent section of the Dam River and the Tuotuo River" offers two cartographical diagrams based on practical survey materials. Data is given to explain that the flow measurement of Dam River is 6.5 times of bigger than that of the Tuotuo River, which indicates that Dam River is the main source of the Changjiang River.

"Natural environment and its change in the source region of the Changjiang River" provides general analysis in those factors like lakes, marshes, desertification of the soil and the frost soil development, pointing out that the circumstances in the river source area tends to be drought and not significant human interference and the climate of the earth is getting warmer.

"Names of terrestrial vertebral animal of Changjiang River valley of Qinghai Province", with a faunal analysis provides a detailed name list of the vertebrata in the area, which is precious scientific materials, while "new found of the human stone implement and its sense in the Dam River mouth in source region of the Changjiang River" provides facts as discoveries about manmade stonewares in the mouth of Dam River and explains its significance. This is the first report that stone implement used by humans were found in the depopulated area around the Dam River. It would be a valuable reference for the exploration of the evolution about the primitives and the changes of the environment.

Only would this great spirit last for ever just as the vave of the Changjiang River will. On the level of this syposium, I think, the authority is only reader. I want to say that the both scientific research and drift-explore of Changjiang River have realized same value of life research and make innovations.

Hou Huiren

June 5, 1989

Secretary of CPC Group of Chengdu Branch of Chinese Academy of Sciences and term of Scientific Research and Drifting Explore of Changjiang River.

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# 长江正源研究

孙广友 邓 伟 邵庆春 华润葵

(中国科学院长春地理研究所)

唐邦兴

浦健辰

(中国科学院成都山地灾害与环境研究所) (中国科学院兰州冰川冻土研究所)

1986年4月,在四川省政府和中国科学院的支持下,中国长江科学考察漂流探险队在成都成立,它肩负着人类首次无动力全程漂流长江和对长江进行科学考察的双重任务。该队所属之科考分队由成都山地灾害与环境研究所、长春地理研究所、西北高原生物研究所和兰州冰川冻土研究所的部分科研人员以及保卫人员和医生组成。在科考漂流探险总指挥部的直接领导下,经过半年的野外考察,在漂流探险分队完成全程征服长江的同时,完成了对长江的综合科学考察。鉴于前人研究程度,这次考察的重点是科学资料缺乏甚至空白的长江上游河源区,对长江正源的考证是其主要内容之一。1986年6—7月,我们完成了有关长江正源的野外考察,尔后又用一年多的时间进行了室内计算分析工作,终于完成了关于长江正源的综合论证,得出了长江正源应当是当曲而不是沱沱河的结论。

野外工作得到西藏自治区和青海省各级政府的大力支持,地方群众也给予热情帮助。科考漂流探险队随队记者兼现场指挥人员资李申、科考分队医生杨启维、警卫干部雍忠,以及漂流探险队的其他同志都给予积极协助。室内分析阶段,长春地理研究所遥感应用研究室、地图研究室和情报图书室在技术设备以及资料信息方面都予以积极配合。长江流域规划办公室石铭鼎、夏鹏章、卢国清三位高级工程师也给予热情帮助。国家测绘局、总参兰州军区测绘处、国家遥感中心资料部等许多部门也提供了许多方便。没有上述部门和同志们的帮助,完成长江正源论证这一复杂而严肃的重大课题是不可能的。本课题承担者对上述单位和同志深表谢意。

## 一、关于长江正源研究的科学价值

长江是中国第一大河,居世界第三位。长江的流域面积达180万 $\text{km}^2$ ,约占全国国土总面积的20%,流域内有3亿多人口,接近全国人口的1/4。长江流域蕴藏着丰富的自然资源,其中水能的理论蕴藏量为2.68亿 $\text{kW}$ ,约占全国的40%,我国的第二大原始森林也分布在长江上游区,攀枝花裂谷还蕴藏丰富的多种有色金属矿藏<sup>[1]</sup>。随着我国四化建设的发展,长江的开发越来越向中上游推进,但对长江的研究却不能适应这种新形势的需要,何况长江河源区不少地方还是综合科学研究的空白区。同时,对长江中上游自然资源和生态环境进行综合研究,为制定长江总体开发战略决策提供科学依据,是十分必要的。