

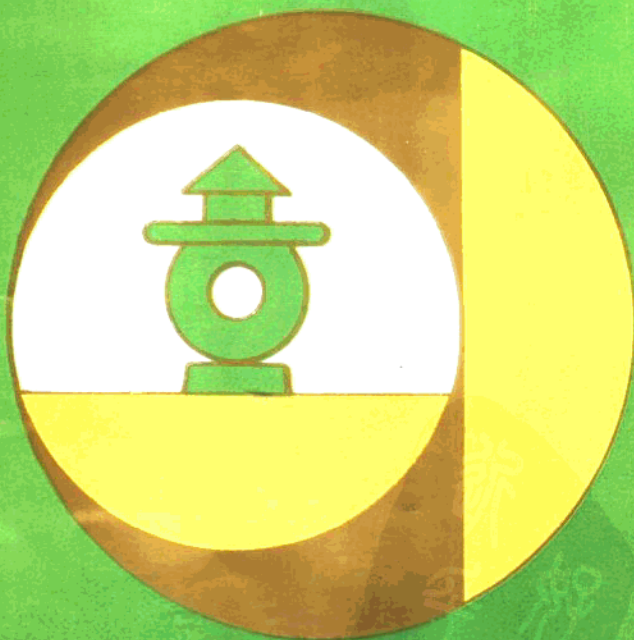
961975

西湖环境研究论文集

THESIS ANTHOLOGY OF
RESEARCH OF
THE WEST LAKE'S
ENVIRONMENT

杭州市环境保护局

杭州市城市科学研究会 杭州市环境科学学会



961975

X321-53
4301

X321-53

4301

西湖环境研究论文集

供第四届国际湖泊环境保护和
管理大会“杭州'90”参阅

中 国

杭州市环境保护局

杭州市城市科学研究会

杭州市环境科学学会

1990年9月

THESIS ANTHOLOGY OF RESEARCH OF THE WEST LAKE ' S ENVIRONMENT

For Reference of
the Fourth International Conference on
the Conservation and Management of Lakes
"Hangzhou ' 90"

CHINA
HANGZHOU BUREAU OF ENVIRONMENT PROTECTION
HANGZHOU INSTITUTE OF METROPOLITAN SCIENCE
HANGZHOU INSTITUTE OF ENVIRONMENT SCIENCE
1990.9

24010/12

EDITOR-IN-CHIEF:	XU YUN HONG		
ASSISTANT EDITOR:	SHENG GANG	CHEN JIE XING	JIN LU NIAN
LIABILITY EDITOR:	SHENG YUE LIN	CHEN JIE XING	
	LENG XIAO	WENG SHI ZHEN	
COMMITTEE MEMBER:	WEI ZHANG YAO	WU AI SHENG	XU YUN HONG
	ZHU LIANG DE	SUN SHUN YOU	SHENG GANG
	SHENG YUE LIN	CHEN JIE XING	LENG XIAO
	JIN LU NIAN	YAO YA QIN	WENG SHI ZHEN



目 录

序 言

杭州西湖简介

第一编 西湖概论

- 1.王宗涛 顾嗣亮 吴静波
西湖的成因、发育及年龄 (7)
- 2.沈耀庭
西湖地质构造的解析 (14)
- 3.张雪尧 董继海
从杭州六公园钻孔取样分析看西湖成因 (21)
- 4.熊 振
论“西湖家族” (25)
- 5.周 勤
西湖特色之研究 (31)
- 6.陈洁行 韦章尧
光辉灿烂的西湖人文景观 (36)

第二编 西湖水体

- 1.金鹿年
杭州西湖富营养物质的来源及其防治对策的剖析 (43)
- 2.宁修仁 史君贤等
西湖水域初级生产力和富营养化的调查研究 (53)
- 3.蒋美珍
杭州西湖富营养化的生物学评价 (63)
- 4.项斯端
西湖藻量动态及其超富营养化生态系统 (71)
- 5.张国勋
西湖富营养状态的模糊数学评价 (77)
- 6.韩伟明 张国勋
杭州西湖底泥释磷的模拟研究 (83)

7.吴静波 焦荔 章永昌	
杭州西湖湖底的表层沉积物	
——内负荷的积累和反馈	(91)
8.朱林范 李梅姿等	
最速下降法在西湖透明度研究上的应用	(101)
9.应晶扬	
杭州西湖流场模型和水质模型	(110)
10.余大进 陶圭棣等	
杭州西湖换水的掺混特性	(119)
11.魏崇德 方永标 章 敏	
西湖引流钱塘江后的生态效应	(126)
12.魏崇德	
杭州西湖治理后的浮游动物现状	(130)

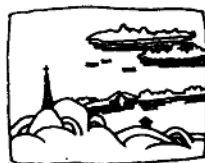
第三编 西湖治理

1.林正秋	
古代杭州西湖的开发及治理	(135)
2.冷 晓	
西湖的治理、保护和开发利用	(141)
3.林霖昌	
古今西湖旱涝状况及进一步治理探讨	(147)
4.孙顺友	
综合整治环境保护西湖明珠	(151)
5.焦 荔	
杭州西湖污染源与防治对策	(155)
6.李梅姿 朱良德	
西湖环境综合整治工程效益探讨	(161)
7.张敦寿 朱国海	
西湖综合治理探讨	(166)
8.朱 丹 乌爱圣	
西湖水体污染的综合整治战略	(172)

第四编 西湖环境

1.肖 峰	
三面云山一面城	
——从美学角度谈杭州城市建设	(177)

- 2.陈洁行
淡妆浓抹应相宜
——浅谈西湖“三面云山一面城”的建设 (182)
- 3.施莫东
西湖旅游环境容量及其对策 (188)
- 4.吴子刚 谭伯禹等
西湖风景资源内涵开拓的探讨 (194)
- 5.陈文锦
论西湖水面拓展、改善水景景观 (198)



CATALOGUE

Preface

A Brief Introduction of West Lake

The First Part: Introduction of West Lake

1. Origin, Developing Process and Age of West Lake (7)
2. Analysis of West Lake's Geological Structure (14)
3. Take the Sixth Park in Hangzhou as a Sample to Explore the Contributing Factor of West Lake (21)
4. Discussion on "The Family of West Lake" (25)
5. Study of Characteristics of West Lake (31)
6. Brilliant Landscape of West Lake's Literature (36)

The Second Part: Water Body of West Lake

1. The Study on Eutrophic Source and its Control Countermeasure of West Lake (43)
2. Investigation of Primary Production and Eutrophication in the Waters of West Lake (53)
3. Biological Evaluation about Eutrophication of West Lake in Hangzhou (63)
4. The Dynamic Variation of Phytoplankton and Hypertrophic Ecosystem of West Lake (71)
5. Evaluation of Trophic State of West Lake—Foundation and Application of Fuzzy Mathematical Model (77)
6. Simulating Study on the Phosphorus Release from the Sediments of West Lake (83)
7. The Surficial Sediment at the Bottom of West Lake—The Accumulation and Feedback of Inner Load (91)
8. Application of Method of Steepest Descent in the Data Treatment of Water Transparency of West Lake in Hangzhou (101)
9. The Flow Model and the Water Quality Model of West Lake, Hangzhou (110)

10. Behavior of Mixing in Diversion Process of West Lake	(119)
11. Ecological Effect upon West Lake with Water Drawing from the Qiantang River	(126)
12. Studies on Zooplankton after Controlling Water Pollution in West Lake	(130)

The Third Part: Administration of West Lake

1. The Exploitation of West Lake in Ancient Hangzhou	(135)
2. Administration, Protection, Development and Utilization of West Lake	(141)
3. West Lake's Aridity and Flood in the Ancient and Modern Times and the Further Management of the Lake	(147)
4. Comprehensively Renovating the Environment to Protect West Lake	(151)
5. Sources of Pollution and Its Solutions of West Lake, Hangzhou	(155)
6. Exploration of the Benefit in the Engineering of the Synthetical Renovation of West Lake's Environment	(161)
7. Discussion on Comprehensive Treatment of West Lake	(166)
8. Strategies of Controlling Water Pollution in West Lake	(172)

The Fourth Part: Environment of West Lake

1. A Lake with Hills on Three Sides and a City on the Other—— An Aesthetic View to the Construction of Hangzhou	(177)
2. Both Light and Heavy Adornment Should Be Suitable—— Discussion of Building West Lake into "A Lake with Hills on Three Sides and A City on the Other"	(182)
3. The Countermeasure to the Tourist Environment Capacity of West Lake	(188)
4. Further Development about the Scenic District of West Lake	(194)
5. Expand the Surface of West Lake, Improve the Lake Landscape	(198)

序 言

杭州市市长 卢文舸

《西湖环境研究》一书在第四届国际湖泊环境保护和管理大会召开之际编印出版，这是杭州的科技工作者赠给大会的一件礼物，也是杭州（在杭各级）科研单位、大专院校和管理部门对西湖环境研究和保护的简要汇报。

杭州这座具有四、五千年历史文化的古都，因为有了西湖这颗“明珠”，被誉为“人间天堂”。西湖，是国家级的十大风景名胜区之一，她在中国的地位十分显著。第四届国际湖泊环境保护和管理大会在西湖之滨召开，说明了西湖正越来越受到世界各国人民的重视。西湖不仅是杭州人民的骄傲，也是中国人民的骄傲。还可以说是全世界人民的骄傲。

翻阅历史，中国伟大的诗人白居易（公元772-846年）、苏东坡（公元1037-1101年）曾经率领人民为治理和保护西湖的环境留下了碑传。今天，在人民政府的高度重视下，西湖的环境保护和建设更是谱写了新的历史篇章。从西湖的环境科学研究、水体治理和保护、沿湖环境的建设和管理、园林绿化等等，已经形成了一个系统工程。今天的西湖，比历史上任何时候都显得更加山青水秀、风光旖旎。

这本小册子收入了三十余篇论文，从西湖概论、西湖水体、西湖治理、西湖环境四个方面，来反映近年来对西湖环境的研究、治理和保护。然而，这只能是这个庞大的系统工程和浩瀚的学术研究资料的一个索引。我衷心期望有更多的专家、学者为西湖的环境治理和保护献计献策，撰辟宏论，使“明珠”更臻光辉。

PREFACE

LU WENG GE

(the Mayor of Hangzhou)

Just as The Fourth International Conference on the Conservation and Management of Lakes is held, the book "Thesis Anthology of Research of the West Lake's Environment" is also published. This book is not only a best gift that the technicians in Hangzhou present to the meeting but also a brief report about the research and protection of the West Lake's environment that the scientific research institutes, the colleges and the departments of administration in Hangzhou have made.

Hangzhou, the ancient cultural capital with a history of four or five thousand years, because of the "pearl"—the West Lake, is praised as "paradise on Earth". The West Lake is one of the ten scenic spots of the country, which enjoys a high prestige all over the world. The fact that The Fourth International Conference on the Conservation and Management of Lakes is held in Hangzhou shows that the West Lake is attracting more and more attention. The West Lake is not only the pride of the people in Hangzhou, but also the pride of all Chinese, maybe it is even the pride of the people of the world.

Looking over the history of China, we can find some memorial biography about the great ancient Chinese poets—Bai Ju Yi (A.D772-846), Su Dong Po (A.D1037-1101), who led the people to harness and protect the environment of the West Lake. Now, under the extraordinary attention of the government, we have composed a new historical chapter. Up to now, we have formed a systematic project of the scientific research about the environment of the West Lake, the harness and protection on the water system, the building and administration of the environment around the West Lake, the greening of the parks and so on. So today's view of the West Lake is more marvelous than ever before.

This pamphlet has collected thirty theses, dealing with four aspects of the West Lake: introduction, water body, administration and environment of the West Lake, which can reflect what we have done in recently years about the research, harness and protection of the West Lake's environment. However, it can only be an index of the huge systematic project and the vast academic research works. I heartily hope that more and more specialists will put forward new ideas and suggestions about the conservation and management of the West Lake and join in our effort to make the "pearl" more shiny and brilliant.

杭 州

杭州，是国务院确定的国家重点风景旅游城市 and 历史文化名城，浙江省的省会，全省政治、经济、文化中心。她，具有四、五千年的历史，建城已 2200 年，中国七大古都之一。历史上素称：“文化之邦”、“鱼米之乡”、“丝绸之府”、“茶叶之都”。

杭州市区位于东经 $120^{\circ}16'$ 北纬 $30^{\circ}15'$ ，面积 430 平方公里，其中 60 平方公里为国家级的西湖风景名胜区。西湖水域 5.6 平方公里，三面云山一面城；因为有了这颗“明珠”，杭州被称为“人间天堂”，成了举世闻名的风景旅游城市。进入 20 世纪 80 年代以来，经济、文化更加繁荣，是国家确定的沿海经济开放区。

西 湖

西湖，是一万二千年前沧海消退时留下的一个礁湖，是大自然赠予人类的一颗明珠。她，水光潋滟，峰峦叠翠，秀丽无比。千百年来，人们对她倍加爱护，不断修琢。中国伟大的诗人白居易（公元 772-846）和苏东坡（公元 1037-1101）等一些杰出人物在任杭州地方长官时，都悉心治理西湖，疏挖湖泥，兴修水利，灌溉农田；而且构成了湖中三岛，白、苏二堤，湖上塔影的佳丽景色。在清漪碧波和绿云翠谷间，有无数秀丽的自然景观和璀璨夺目的历史古迹。

本世纪 50 年代以后，西湖的环境保护和建设展开了新的篇章，尤其是 80 年代以来的 10 年，写下了崭新的一页。沿湖敷设了污水截流管道 10 公里；疏浚挖湖泥 760 万立方米，使西湖平均水深达到 1.5 米；蓄水量达 850 万立方米，比原来增加 2 倍。建成了 3137 米长的钻地穿山引水渠道，日引钱塘江水 30 万吨入西湖；又把湖中的燃油船只全部改成电瓶船；湖上有近 10 条船每天坚持打捞漂浮物；从而

保证了湖水明净。湖周围也已实现无黑烟区；扩大延伸了环湖绿地 8 万平方米；在周围山林，新植树 3290 万株；新建、整修、恢复了大批风景名胜点。今天的西湖，更显得山青水秀，风光旖旎。

HANG ZHOU

City of Hangzhou, designated by the State Council as the key scenic and tourist city distinguished with rich cultural and historic background, is the capital of Zhejiang Province, focusing the political, economic and cultural activities of the province. It enjoys 4,000 to 5,000 years of historic and cultural civilisation. Having been established as a city for 2,200 years, it is reputed as one of seven great ancient cities in China. It is crowned with many glories during its development, such as: Kingdom of Culture, Home of Fish and Rice, Capital of Silk, and Land of Tea.

The city is properly located in the 120° 16' E longitude and 30° 15' N latitude, covering an area of 430 square kilometres, of which the national level West Lake Scenic Zone takes up 60 square kilometres. The West Lake holds 5.6 square kilometres of water area, cradled on three sides by hazy mountains. The lake is commonly associated with a bright pearl. Thanks to the bright pearl, Hangzhou is known as palace on Earth, and popularly regarded as the world famous tourist and scenic city. Entering 80's of the 20th century, its economy and culture are more flourishing. The state has announced Hangzhou as an open city along the coast region.

WEST LAKE

The West Lake evolved into a reef lake 12,000 years ago when sea retreated and left behind a glittering pearl endowed by nature. With shimmering ripples and a luxurious verdure carpeting the surrounding undulated mountains, Hangzhou presents to the world its full irresistible charms. Over a thousand years, the lake was indulged and embellished by posterities. Great poets Bai Juyi (772-846AD) and Su Dongpuo (1037-1101AD), and other dignitaries, scrupulously tended the West Lake, ordered it dredged, and encouraged water conservation and irrigation projects during the time when they were administrators of Hangzhou. As a legacy of their efforts, there appeared a beautiful landscape, three charming isles jutting out of the lake, Bai and Su Courseway dividing it, and pagodas overlooking the lake. Scattering among the rippling clear waves and green valleys are charming clusters of natural scenes and historic relics.

After 50's of the century, the construction and environment protection of the lake

gained new momentum. Especially, the ten years of 80's witnessed a series of new projects accomplished. Ten kilometres long pipe has been laid down to halt sewage from polluting the lake, and 7.6 million cubic metres of silt has been dredged out. Now after the work, the average depth of the lake is 1.5metres. Its water conservation capacity reaches 8.5 million cubic metres, doubling the original capacity. A 3.137metres long canal has been dug through hills to lead the daily flow of 300,000tons of the Qiantang River water into the lake. And all diesel projected boats are converted into electric projected boats. There are 20special boats every day to collect floating litters on the lake, thus ensuring the water clean and clear. The lake area has become non-smoke zone and green land has expanded 80,000square metres. In the neighboring mountains, 32.9million trees were planted. What is more, the city recently built, embellished and renewed numerous scenic spots. Today the West Lake Scenic Region lays out an unmatched landscape with softly rolling hills and beautiful lake setting.





西湖的成因、发育及年龄

王宗涛 顾嗣亮 * 吴静波

一、引言

杭州作为一个举世闻名的花园城市,西湖的存在具有决定性的意义。但无论是地质记录还是历史文献记载,都表明西湖曾经经历过一系列变化,有其自身的形成和演化过程。无疑,正确地认识西湖的成因及其发育历史,不仅具有理论意义,而且对于湖泊的治理和杭州城市的发展具有一定的现实意义。本文根据笔者对西湖及其附近地区的地貌调查,西湖底质分析及若干 ^{14}C 测年数据,并综合了前人的有关研究成果,检验了包括西湖三岛(小瀛洲、湖心亭、阮公墩)在内的众多钻孔资料,对西湖的形成、发育和年龄提出了一些新的认识。

二、研究简史

西湖独特的自然风貌,既吸引了众多古今游人,也引起了不少中外学者的注意和研究。

早在1909年,日人石井八万次郎⁽¹⁾曾对西湖的形成作过一些议论。1921年,我国已故著名科学家竺可桢认为西湖在成因上属于礁湖(lagoon),并正确地指出:“西湖若无人工的浚掘,一定要受天然的淘汰。”⁽²⁾1924年,章鸿钊提出西湖生成有两个基本条件,一为潮力所向,积成湖堤,二为水位变迁,维持湖命。又认为西湖始成于汉,当时湖面的涨落受潮汐的控制⁽³⁾。1939年高平⁽⁴⁾、1948年朱庭祐⁽⁵⁾等对西湖的形成也有所论述,但未提出新的见解。特别值得一提的是,陈吉余于1947年、1948年和1955年数次撰文,以美国学者D·W·Johnson的海岸发育理论来阐释西湖的生成^(6, 7, 8)。意谓西湖所在原为海湾,海水可直拍灵隐山,西湖南北各有一个海岬,南为吴山、紫阳山,北有宝石山,两个海岬前端在沿岸流的作用下产生湾口沙洲。两个沙洲不断延伸,互相交接,则西湖与大海隔绝而成泻湖,所以目前杭州市区是湾口沙洲。这在当时缺乏众多钻孔资料和淤泥质海岸发育理论尚未建立的情况下,无疑是一种合乎逻辑而又新颖的见解,故长期以来已得到有关科普读物、教科书和许多涉及杭州历史的论著的广泛引用,影响颇深。1979年,汪昌先等对西湖湖滨的二个钻孔所采取的岩样进行了微体古生物分析,根据不同的化石组合将西湖在全新世时期的发育划分出早期泻湖、中期海湾、晚期泻湖等三个阶段,并指出“随着钱塘江沙坎的发育,西湖终于完全封闭,水体逐渐淡化,形成了现代的西湖”⁽⁹⁾。1985年,陈桥驿根据古籍考证,从历史地理的角度阐述了西湖发育演变与杭州城市发展的关系,指出了西湖之所以能够保存至今的原因⁽¹⁰⁾。吴维棠则认为西湖早在春秋时期就已经沼泽化了⁽¹¹⁾。

综上所述,可见除石井氏之外,各家对西湖的形成与发育的见解在以下几个方面是比较一致的:1.西湖本是海湾,由于海湾南北两岬对峙之处泥沙的堆积,亦即所谓湖堤、湾口沙

洲或沙坎的发育,使西湖与大海完全隔开,终成泻湖;2.西湖形成的时代不很久远;3.现今的西湖之所以能够存在,实为人工疏浚之故。

三、关于西湖的成因

“泻湖”一词的定义,《牛津英语词典》有两种解释:一种是“被低沙坝或砾坝与海隔开的咸水或半咸水区”,另一种是“由环礁封闭的类似于湖泊的水域”。显然,假如西湖是泻湖的话,应属前者,即海岸泻湖(coastal lagoon)。按照这一定义,海岸泻湖与封闭它的沙坝或砾坝有十分密切的关系,亦即任何泻湖不论其大小如何,都具有这种关系^[12]。这也许就是为什么前人在论述西湖为一泻湖时,总是试图用湖堤、湾口沙洲或沙坎等类似于沙坝的特定地貌形态来加以解释的原因。但无论是对地表地形、地质的观测,还是对地下堆积体的展布与沉积特性的分析结果,其基本事实似乎均与这种解释相悖。

(一) 地面高程的空间分布,并不显示有沙坝存在。

通过查阅1/1万地形图以及众多工程地质钻孔孔口标高的分布,可以得知杭州市区目前的一般地面高程(黄海,下同)约8米,其中上城区高于8米,最高处出现在羊坝头、浙二医院、茅廊巷菜场等地附近,局部可大于9米;下城区一般低于8米,西湖四周也在7.5米左右,唯东北角高程最低,如昭庆寺及其附近约6米,昭庆寺愈往东北和北方,高程逐渐降低到5米、4米,乃至3米左右。诚然,杭州市老区(包括今上城区、下城区以及拱墅、江干区的一部分)的地面高程在很大程度上受到人工填土、筑路、建塘等人类活动的影响,应作具体分析,但上述高程分布至少可以说明,从西湖北面的宝石山到南边的吴山一带,高出西湖的堤状湾口沙洲是不存在的。

(二) 钻孔资料表明,地下并无沙坝的痕迹。

随着杭州城市建设的发展,有关水文地质与工程地质部门已在市区(包括西湖在内)完成了数以千计的各类钻孔。笔者检验了部分具代表性的钻孔资料,其结果显示,杭州市区平原的组成物质(埋深在15米以内)都以平均中径5—10 Φ 的粉砂、淤泥为主,在西湖东侧并未发现有任何坝状沙体的存在。

(三) 大潮差对泻湖的形成是一个不利因素。

R·S·K·Barnes曾经着重指出,世界上凡海岸泻湖广泛发育的地区都具有较小的潮差^[12]。这是因为,潮差大的地区海面不稳定,波浪作用分散而相对较弱的缘故。T·ELLIOTT在论述泻湖及其沉积时,用相当大的篇幅讨论了小潮地区与中潮地区之间所存在的差异^[13],却未涉及大潮地区的泻湖及其沉积特性。我们不应该将此理解为某种疏忽,而只能认为大潮地区的泻湖是罕见的。浙江目前的大陆岸线总长2253公里,绝大部分属于大潮海岸,迄今竟未发现有任何现代泻湖的发育。杭州湾地区更是著名的大潮地区,以澉浦为例,多年实测平均潮差为5.38米,最大潮差达8.87米。在这一总的背景之下,细颗粒泥沙供应充裕的海岸地区,塑造地貌的主要动力因素理应是潮流而不是波浪。这也许就是西湖东侧平原未见沙坝发育的重要原因之一。

(四) 钱塘江河口沙坎的发育对西湖的完全封闭是否超过某种作用,尚待进一步研究。

图1和图2是根据地貌调查和一系列钻孔资料绘制而成的,分别从平面上和垂向剖面上揭示了东部钱塘江河口沙坎分布区与西部海积——湖积平原区的相互关系。从平面上看,这