中国典型滑坡

LANDSLIDES IN CHINA-SELECTED CASE STUDIES

殷跃平　主编
Editor-in-Chief Yin Yueping

中国大地出版社
China Land Press

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内 容 提 要

《中国典型滑坡》是一本以照片形式反映我国典型滑坡的画册，包括了顺层滑坡、第三系泥岩滑坡与崩塌、黄土滑坡、风化层与堆积层滑坡、地震与冰雪型滑坡及堰塞湖、水库滑坡、矿山滑坡与崩塌、城市建筑和道路滑坡等8大滑坡类型。通过精选照片的展示形式，以简要文字阐述了滑坡所处地理位置、地质环境、形态结构特征、稳定性、灾害程度以及防治工程等。本画册收录了近几年来我国发生的非常具有典型意义的滑坡，例如西藏易贡滑坡(2000)、湖北秭归千将坪滑坡（2003）、四川宣汉天台乡滑坡(2004)、青海阿尼玛卿山滑坡（2004）等。本画册也收录了我国历史上非常著名的滑坡，例如陕西西安翠花山滑坡（公元前780）、重庆黔江小南海滑坡(1856)、宁夏海原地震滑坡（1920）、四川岷江叠溪滑坡（1933）等。针对三峡库区移民迁建工程的地质灾害防治，本画册还收录了大量的滑坡及防治工程实例，并提供了若干利用滑坡体进行综合整治和土地利用的实例。

本画册是一本非常珍贵的滑坡史料，可供地质、地震、水电、公路、铁路、矿山、国防工程等领域的生产、科研人员以及有关院校的师生参考。

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前 言

由国际土木工程学会土力学与岩土工程分会、国际岩石力学与工程学会和国际工程地质与环境协会联合主办的第10届国际滑坡与工程边坡会议将于2008年6月30日至7月4日在西安举办。这次会议是全球滑坡和工程边坡学术界的一次盛会。应大会组委会主席陈祖煜教授之约，由我主持编著《中国典型滑坡》画册，用图片方式向世界展示我国典型的滑坡特征。

2004年，当陈祖煜院士告诉我要出版此画册的想法时，我原本以为这是一件难度不大的事。因为，国土资源部开展了全国1500多个山区丘陵县、市的地质灾害调查，我和我的同事们也长期从事全国范围的滑坡调查、勘察、防治与研究，手中握有大量的资料。但是，实践起来后方感难度颇大。我国的滑坡类型繁多，千差万别，如何通过这一画册向世界同行展示，争论激烈。最后，吸收了Varnes对滑坡的广义分类方案，并结合我国的滑坡分类习惯，不强调学科分类的完整和严谨，也不刻意追求画面的艺术效果，而是从专家的视角，利用手中的普通相机，呈现我国典型的滑坡形态特征，并力求从滑坡结构、灾害及防治等角度加以充实。

《中国典型滑坡》画册按照顺层滑坡、第三系泥岩滑坡与崩塌、黄土滑坡、风化层与堆积层滑坡、地震与冰雪型滑坡及堰塞湖、水库滑坡、矿山滑坡与崩塌、城市建筑和道路滑坡等8种类型，通过精选照片的展示形式，以简要文字阐述了它们所处地理位置、地质环境、形态、结构特征、稳定性、灾害程度以及防治工程等。本画册收录了近几年来我国发生的非常具有典型意义的滑坡，例如西藏易贡滑坡(2000)、湖北秭归千将坪滑坡（2003）、四川宣汉天台乡滑坡(2004)等一系列滑坡，也收录了我国历史上非常著名的滑坡，例如四川岷江叠溪滑坡(1933)、重庆黔江小南海滑坡(1856)等。针对三峡库区移民迁建工程的地质灾害防治，本画册还收录了大量的滑坡及防治工程实例，并提供了若干利用滑坡体进行综合整治和土地利用的资料。

《中国典型滑坡》画册终于出版了。感谢编著组的同事们，为了获取滑坡的资料付出了非常艰辛的努力。几乎每一张图片背后都有非常动人的故事。编著组强调画册不是简单的照片罗列，因此在本画册编著过程中专门考察了大多数滑坡，提供了大量第一手资料。例如，西藏、青海地质环境监测站等单位的专家多次深入氧气稀少、交通不便的高寒地区，获取了不同时期的第一手资料。

感谢全国的同行们，没有大家的无私帮助，根本不可能如愿。在西藏、青海、新疆、甘肃、陕西、宁夏、山西、云南、四川、重庆、贵州、湖北、浙江、江西、辽宁等地收集资料时，省（区、市）国土资源厅（局）、地方人民政府和其他各级国土资源部门，都为我们提供了非常便利的交通和安全保障。

感谢美国伊利诺大学Alberto S. Nieto教授、清华大学张建红博士、华中科技大学汪华斌博士。他们牺牲了宝贵的休息时间，提供了非常流畅、贴切的英文翻译。

最后，特别要感谢中国科学院院士陈祖煜教授，他亲自策划了本画册的编著，并自始至终给予了无私指导。

殷跃平

2007年10月

PREFACE

The 10th International Symposium on Landslides and Engineered Slopes (10th ISL), to be held from June 30 to July 4, 2008 in Xi'an, China, is one of the most important activities of the Joint Technical Committee on Landslides and Engineered Slopes (JTC 1) under the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), International Society for Rock Mechanics (ISRM) and International Association on Engineering Geology (IAEG). In memory of this unique chance of hosting this Symposium, I was assigned by the Chinese geological and geotechnical communities to coordinate and technically edit a photo album entitled "Landslides in China - Selected Case Studies", in an effort of best illustrating typical and disastrous landslides in China.

Landslides include diversified gravitational mass movements that are triggered by earthquakes, rainfall, volcanic eruptions and human activities. This natural hazard has brought painful damage to inhabitants living in hilly and mountainous terrains, escarpments and river valleys around the world, especially in the developing countries. China has recently completed a landslide survey that covers 1500 counties in hilly regions with the financial support provided by the Ministry of Land and Mineral Resources. My colleagues and I have collected a large amount of data. However, it seems not an easy task while editing this volume under the coordination of Professor Chen Zuyu, Chairman of 10th ISL. Landslides include various and complicated types, some of which are unique, completely different from those in other countries. Of utmost concern is the framework of this book that could best classify and illustrate Chinese landslides with varied types and complex geological features, so that this Album can best benefit our international peers. To bridge the gap between Chinese and international practice, this book adopts the landslide classification criteria proposed by Varnes (1978), which feature is emphasizing the movement characteristics and material types of a landslide. Due considerations of Chinese traditional experience for landslide classifications are also given. The photos contained in this Album are taken by geologic experts using ordinary cameras, aimed at presenting the diversified landslide morphology and characteristics with sufficient descriptions of geological structures and approaches for hazard mitigations. The academic rigorousness and architecture impact of this book have been considered of secondary importance.

In this book, landslides are selected into eight types: (1)landslides on dipping beds; (2) mudslides and falls in Tertiary materials; (3) landslides in loess; (4) landslides in weathered and colluvial materials; (5) avalaches and damming induced by earthquake and snowmelt; (6) landslides induced by reservoir filling; (7) landslides and rockfalls induced by mining; (8) landslides induced by urban development and highway. Most photos shown here were taken by experienced engineers working on landslide investigation and mitigation projects, with limited concern on their artistic effects. Informations about these landslides are focused on their geographical location, geological conditions, structural characteristic, stability status, hazard potential and mitigation approaches, etc. It is worthwhile to note that several historical landslides are included, e.g., the Yigong landslide in Tibet (2000), the Qianjiangping landslide in Zigui of Hubei Province (2003), and the landslide at Tiantai Town in Xuanhan of Sichuan Province (2004), etc. Several disastrous landslides triggered by earthquakes are also presented in the album, for example, the Diexi landslide which dammed the Mingjiang River in Sichuan Province in 1933, and the landslide dam created in the Qianjiang River of Chongqing City in 1865. In addition, case studies on landslide mitigation programs in the Three Gorges Reservoir have provided useful information on comprehensive landslide prevention and management approaches and land use, planning and development strategy.

This album was produced by individuals who, in spite of their demanding workload, volunteered their time and talents to offer their contributions. The organizing committees and the future users of this volume are indebted to the members of the editorial board for their efforts. Most sincere appreciation is expressed to all those who contributed information in the forms of data, photographs, ideas and advices, without which this album could not have been made possible. Thanks go to my colleagues from the Geological Environment Monitoring Stations in Tibet and Qinghai, etc., who circumvented many difficulties to get valuable photos under severe natural conditions such as lack of oxygen, inaccessible high-latitude and permafrost regions. The support on transportation facilities and security from local government in many counties and provinces is gratefully acknowledged. To list all of the contributors would be impossible; and to mention some of them would be unfair to the others.

I express my gratitude to Professor Alberto S. Nieto from the University of Illinois in USA for his time on English editing of this book, associated with Dr. Zhang Jianhong at Tsinghua University and Dr. Wang Huabin from Huazhong University of Science & Technology.

Special thanks go to Professor Chen Zuyu, Academician of China Academy of Science, for his great contribution and help in producing this photo album.

Yin Yueping
China Geological Survey
October, 2007

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1. 顺层滑坡

Landslides on Dipping Beds

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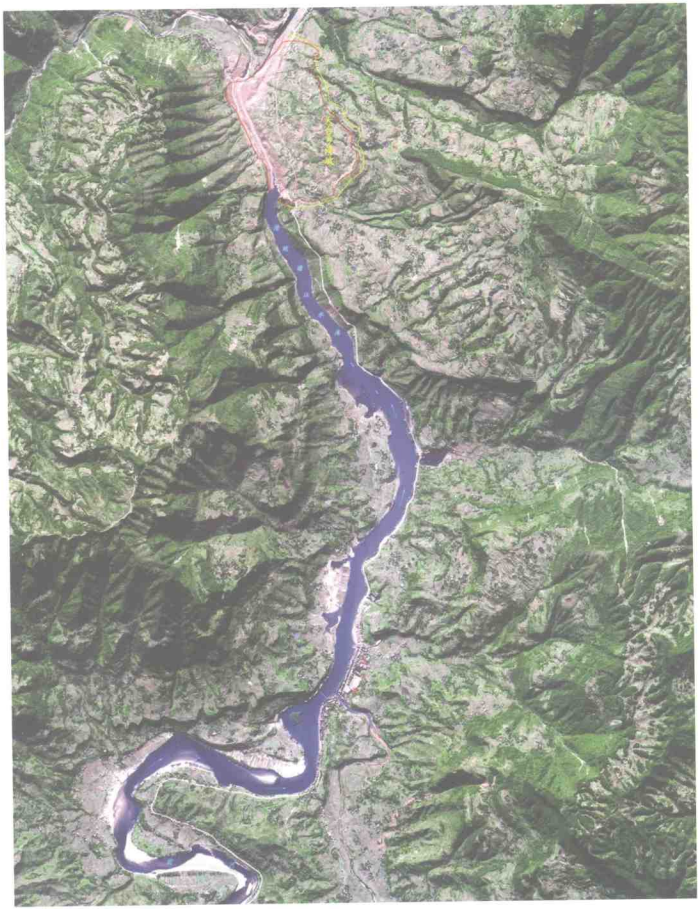
四川宣汉天台乡特大滑坡

Large Scale Landslide at Tiantai Village, Xuanhan County, Sichuan Province

滑坡发生于2004年9月5日，暴雨诱发。1255人受灾，摧毁房屋2983间，毁田1097亩。属基岩顺层滑坡，平面形态呈“圈椅”状，纵长950～1200m，横宽1400～1600m，面积1.2km^2。滑床以砂岩为主，后陡前缓的折线形，前部顺层滑动，坡度5°～7°，后部切层，坡度渐变为20°～40°，主滑方向95°。滑体以紫红色粉质粘土夹泥岩块石和泥岩碎裂岩体为主，厚度一般为7～49m，平均厚度23m，滑体总体积2500万m^3，其中约210万m^{3}堆积物冲入前河中。

The Tiantai landslide occurred on September 5, 2004, due to heavy rainfall, 2983 houses and 1097 Mu of farmland were destroyed; 1255 persons suffered damage. It was lobate shaped in plane view with dimensions in 950-1200 m long, 1400 -1600 m wide, 23 m thick. The basal bed is a sandstone layer dipping 5°- 7° at the toe and 20°- 40° near the crest. The landslide has a volume of 25 million m^3; is made up of purple-red silty clay with intercalations of mudstone. About 2.1 million m^3 of sliding materials caused the damming of the river.

·四川宣汉天台乡特大滑坡·



滑坡及堵江回水遥感影像
Image showing landslide dam and impounded water

（本照片由王治华提供）

滑坡前“3D”遥感影像　Oblique image before sliding

滑坡后“3D”遥感影像　Oblique image after sliding

滑坡前部冲入前河中，抬高河床23～28m，造成河道严重堵塞，形成回水长15km、库容5800万m^3的堰塞湖。淹没上游五宝场镇及沿河两岸共8个村5770户，农田4930亩，紧急转移受灾群众19 360人。

The landslide dammed the river and water level rose 23-28 m creating an impoundment 15 km long and 58 million m^3 in volume. Eight villages were flooded and 19 360 persons were evacuated.

滑坡淹没上游村镇　Submerged village due to landslide impoundment

（本照片由赵松江提供）

（本版遥感影像由中国国土资源航空物探遥感中心提供）

滑坡前缘剪出入江，地下水沿滑带渗出
Groundwater discharge along sliping zone

滑坡剪出滑入江，形成滑坡坝体
The sliding mass fell into and dammed the river

入江滑坡体形成堰塞湖
Landslide debris sliding and damming river

滑坡体前缘概貌
View of landslide accumulation

滑坡下伏滑床砂岩呈层状碎裂岩体，富水性好
Laminar sandstone at the base of the sliding mass initially large amount of water

滑坡体孤丘
Sliding isolated pinacle

滑坡下伏滑床为砂岩泥岩互层结构
Interbedded sandstone and mudstone at the base of the sliding mass

（本照片由赵松江提供

滑坡柱体
Sliding isolated pinacle

残留滑坡柱体显示滑坡原厚度和结构
Residual pillar showing the structure and thickness of landslide

滑坡变形拉裂，树木歪斜
Trees tilted due to sliding

滑坡变形拉裂形成醉汉林
Drunk trees due to sliding

稻田水渗入滑坡体，促进了滑坡的变形拉裂
Water seepage from rice field increased deformation and cracks

滑坡变形拉裂，稻田下陷成地堑
Rice field subsidence due to sliding

稻田被毁，田水入渗促使滑动加剧
Rice field destroyed by sliding, resulting in water seepage and exacerbating landsliding

池塘被毁，池水入渗促使滑动加剧
Sliding destroyed this pond; then water seepage worsened sliding

（本照片由赵松江提供）

三峡工程重庆库区云阳老县城五峰山滑坡

Wufengshan Rockslide in Old Yunyang Town, Chongqing, Three Gorges Reservoir

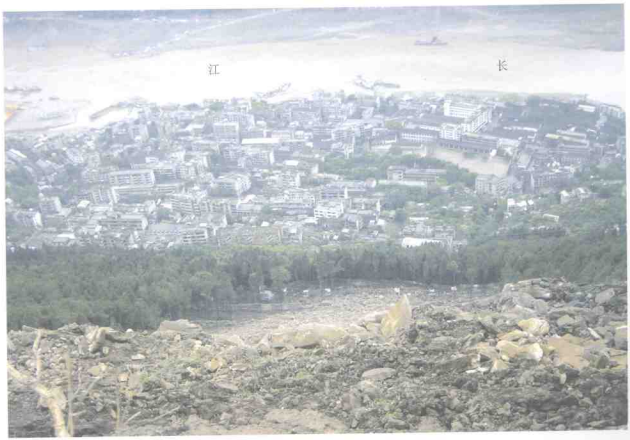
云阳老县城滑坡：老县城坐落在西城滑坡体上，后山为五峰山滑坡
Yunyang Town is located on the Xicheng landslide and the Wufengshan rockslide can be seen behind

滑坡发生于2001年1月17日，从高程607.7m顺层下滑，沿570m高程处剪出，并带动老滑坡残体碎块石土顺层下滑，堆积于380～410m高程上。体积3万m^3左右。危及1.2万余人生命财产安全。滑坡原岩为遂宁组第二段中厚层石英粉岩夹薄层泥岩，地形坡度及岩层倾角近于一致，为48°～54°，层面裂隙及纵横向节理裂隙发育，前缘临空条件好，且前缘360m左右高程有地下水溢出。

滑坡发生后，当地政府迅速组织有关单位进行应急处理，确保了春节和汛期期间人民生命财产的安全。

Wufengshan rockslide occurred on January 17, 2001, and had a volume of 30 000 m^3. The translational rockslide is made of inclined bedding Tertiary quartz sandstone with intercalations of weathered mudstone. The bedded rockmass is fractured and weathered, and the groundwater is discharged at the toe zone of the landslide, endangering over 12 000 persons.

The Wufengshan rockslide has been controlled, and the town has been relocated.



五峰山滑坡对老县城1.2万余人生命财产构成严重威胁
The Wufengshan rockslide endangering over 12 000 persons below

五峰山滑坡转化为泥石流，对下部居民构成威胁
The rockslide became a debris flow, endangering houses

五峰山滑坡沿单斜岩层顺层滑动
The Wufengshan rockslide moving along stratified layer