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工程地质遥感判释与应用

(第二版)

卓宝熙 编著

中国铁道出版社

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内 容 简 介

本书对我国半个多世纪的工程地质遥感判释经验和应用情况进行了较系统地总结,同时简要介绍遥感技术及其当前最新进展。主要内容包括遥感信息技术简介、遥感图像工程地质判释、遥感技术在各种工程地质调查中的应用等。其中遥感技术在各种工程的地质调查中的应用部分,在国内同类书中未见介绍,是遥感工程地质应用的最新成果总结。

本书可供工程遥感专业技术人员参考,也可供相关专业科研、教学人员使用。

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序

铁道部工程勘察大师卓宝熙同志,送来他编著的《工程地质遥感判释与应用》的新稿。这是他1982年编著的《遥感原理与工程地质判释》的姊妹篇。这两部专著的看着点和思路迥然不同,但又是相辅相成,优势互补的。

东西方的语言和思维方式不同,解决问题的方式、方法也有区别。例如,西餐用刀叉,在餐桌上现切、现割;而中餐只用筷子,切割的功夫在厨房里早就解决了。面对工程问题,不等同于技术攻关,一系列问题都要在方案设计、型号实验进程中预先解决。集成程度很高,综合性很强,系统误差的积累和长寿命稳定性的矛盾,必须作出充分的估计。在这部新著中,关于一般的遥感信息科学技术原理的论述,笔墨不多;重点是在第三篇各章,面对遥感在铁路、水利、公路、油气管道、电力和港口等工程中地质问题的调查、研究与分析应用。这是作者从诸多领域和大量工程实践中凝炼出来的精髓之作,填补了国内在遥感工程地质应用方面的空白。实践出真知,来自实践而又高于实践。正是勘察大师们的出神入化的大手笔,也是学习毛泽东同志《实践论》的成功范例。

新著不落俗套,不是从一般原理、方法到应用,即从理论到实践。而是另辟蹊径,遵循经典的中国式逻辑方法,即从实践问题出发,探索一些概念、方法,去充实和补充一般原理,用于后来解决新的实际问题。正如英国波普尔(Karl Popper)所表述的简单模式:根据问题,进行尝试性解决,排除错误,去寻求解决新问题的正确方案。(见拙著《客观知识》)。在这部新著里,简明扼要地介绍一般遥感信息技术方法之后,其中第二篇主要针对工程地质中有关的地貌、岩层、地质构造、不良地质、水文地质等问题,推陈出新,这样的体例也是别出心裁的。这样经过二次深加工的知识,就是最便于推广和很有应用价值的学问了。

欣逢新世纪之初,又是万物复苏的春夏之交。人们像蜜蜂一样忙忙碌碌。好像一年365天,几乎都要安排上形形色色的世界节日。植树节、环保周、地球日、湿地日打扮着绿色的春天;劳动节、青年节、母亲节、电信日、无烟日烘托着红色的5月……似乎世界上再也找不到宁谧的日子;地球上充满着喧闹的噪声。当我正

在为此而困惑不解的时候,读到了大师的佳作,看到他们茹苦含辛地工作,淡泊明志,宁静致远,直面现实,秉烛达旦,采花酿蜜,为我们留下宝贵的科学财富,我的浮躁不安的心情,很快就安静下来了,为有这些辛勤耕耘的科技界老朋友而自豪,也为他们这些科技兴国的好榜样而欢呼!

A handwritten signature in black ink, reading '陳述彭' (Chen Shuping) in a cursive style.

于 2001 年世界地球日

Preface

Zhuo Baoxi, an engineering survey master, sent his new work Remote Sensing Interpretation & Application of Geology Engineering to me. This is the companion volume of Remote Sensing Principle and Interpretation of Engineering Geology, his another work that was published in 1982. Although the focus and the train of thought of them are quite different, they supplement each other.

How the East and the West solve problems varies with the linguistic and thinking pattern of them. For example, one has to cut the western food with knife and fork when eating at a table, but for Chinese food, whatever needs to be cut is cut in kitchens. Solving engineering matters is not merely about tackling the technical key problems. A series of issues have to be settled in the stage of project design and model test. The conflict between degree of integration, comprehensiveness, system error accumulation, and longtime stability must be fully evaluated. His new work doesn't discuss too much about scientific and technological principles of remote sensing information. The emphasis is laid on the third part – investigation, research and analytical application of remote sensing in geological matters encountered in the fields like railway, irrigation, highway, oil – gas pipeline, power, and harbors. It is the essence extracted from the author's massive project experiences in many fields, and fills the gap in China's geological remote sensing application. Genuine knowledge comes from practice, but goes farther. The work, representing the exquisite workmanship of master surveyors, is a successful example of learning from Mao Zedong's On Practice.

Instead of following the conventional pattern, which usually starts from general principles and methods and ends with applications, so called "from theory to practice", new work strikes out in another way, following Chinese classical logic to probe into some concepts and methods on the basis of practical matters. General principles, which are substantiated and supplemented from these concepts and methods, are adopted to solve new problems which one meets in real life. An Englishman, Karl Popper, put forth a simple mode: one should try to solve problems and find errors, so as to seek for a correct solution to a new problem (see Objective Knowledge written by him). After introducing remote sensing IT methods that are commonly used, the second part of the book puts forward new ideas about landform, strata, geological structure, unfavorable geology and hydrogeology, which people often meet in engineering geology. This is an ingenious style. Such secondary – processed knowledge of practical value can be popularized easily.

On the happy occasion of the beginning of the 21st century, a time of rebirth when spring is changing into summer, people are as busy as bees. It looks that they treat everyday as a festival. In green spring, there are Tree Planting Day, Environmental Protection Week, Earth Day, and World Wetlands Day; in red May, there are International Labor Day, Youth Day, Mother's Day, Telecommunication Day, and No – Smoking Day. ... it seems difficult for us to find a quiet time in the world. There are loud noises everywhere. When I felt puzzled about this, I read this masterpiece.

Looking at it, I appeared to see the author, who lived a simple life, working overtime at night. Facing the reality, he worked hard and quietly, just like a bee that gathers nectar and makes it into honey, in pursuit of leaving valuable wealth of science to us. At the thought of this, I stopped fidgeting and calmed down soon. I was proud of having an old friend who committed himself to the scientific and technological work body and soul, and cheered for good examples like him who devoted themselves to revitalizing the country with science and technology!

A handwritten signature in Chinese characters, which appears to be '陳述彭' (Chen Shu Peng), written in a cursive style.

2001 World Earth Day

再版说明

《工程地质遥感判释与应用》第一版于2002年由中国铁道出版社出版发行,该书系由铁路科技图书出版基金资助出版。发行后获得了有关专家的广泛好评,尤其是得到了相关专业现场技术人员、科研和教学人员等读者的青睐,并荣获“第十一届全国优秀科技图书奖”三等奖。为满足广大专业人员的需要,决定请作者修订并再版此书。

该书出版至今已达8年,部分内容已不适应当前的需要,再版前对原书内容进行了修改、补充,资料截至2010年12月底,时间跨度达半个多世纪,主要修改和补充内容如下。

一、原书共十六章,现为十八章,原书字数104万字,再版书120万字。

二、第一篇第一章“遥感信息获取”补充了部分新的内容;第二篇各章均未作补充修改;第三篇补充、修改较多,主要是补充一些新的应用实例,其中,第十二章至第十五章均补充了一些实际应用实例,第十六章,将其中港口工程的应用,分出另列为第十七章。另外,增加了第十八章“遥感技术在地质灾害监测与调查中的应用”。

三、原书中部分线划图的线条和符号不规范的,均作了修改。

本著作乃广大工程地质遥感工作者的劳动结晶,自非众擎之力难为功。幸得同行鼎力相助,方完成再版稿。

参加本次书稿补充、修改原则上仍以原书编写的人员为主,其中第一章由北京交通大学吴景坤负责;第十二章由中铁工程设计咨询集团有限公司的胡清波、铁道第三勘察设计院集团有限公司的乔平负责;第十三章由水利部长江勘测技术研究所、水利部长江水利委员会长江流域水土保持监测中心的周乐群、姚俊虎、李平治、吴玉华、袁登维、胡宗云、高盖萍等负责;第十四章由陕西公路勘察设计院戴文含负责修改;第十五章由中国石油勘探开发研究院的于世勇负责;第十七章由华东师范大学的恽才兴负责;第十八章由中国国土资源航空物探遥感中心的杨日红负责。值此再版付梓之际,自当铭感申谢。虽赖众力成书,但因编著者水平所限,书中难免有错漏和不妥之处,望读者不弃而予赐教。

出版者与编著者
2011年6月

Statement of Republication

The book *Remote Sensing Interpretation & Application of Engineering Geology*, sponsored by Railway Science & Technology Book Publication Fund, was printed and distributed by China Railway Publishing House in 2002. It was well received by professionals and experts, especially by some specialized technical, scientific research and education personnel. It won the third prize of the 11th National Excellent Science and Technology Book Award. To satisfy the needs of many professionals, we decided to publish this book.

As eight years passed by, part of the contents lagged behind current needs. The book was revised and supplemented before republication. It covers the data generated from as early as half a century ago to late December of 2010. Main revisions and supplements are described below.

I The number of chapters it covers changes from sixteen to eighteen. There are totally 1,040,000 Chinese characters in original edition, but nearly 1,200,000 in the second edition.

II Something new was added to Chapter 1, Part 1: “Remote Sensing Information Acquisition”. No chapter in Part 2 was revised and supplemented. Much changed in Part 3, where some new application examples were added (e. g. , several practical application samples were inserted in Chapter 12 to 15) and the part about application in harbors was separated from Chapter 16 and included in Chapter 17. Furthermore, Chapter 18 “Application of Remote Sensing Technology in Geological Hazards Monitoring and Investigation” was added.

III. Some lines and symbols used to draw a picture in the original edition were irregular, and therefore they were modified.

This book is the fruit of labor of many remote sensing workers. Many hands make light work. Fortunately, we got your great support and finally finished the second edition.

In principle, it fell to the authors of original book to revise and supplement this book. Chapter 1 was under the responsibility of Wu Jingkun from Northern Jiaotong University; Chapter 2 was under the responsibility of Hu Qingbo from China Railway Engineering Consulting Group Co. , Ltd. and Qiao Ping from China Railway Third Survey and Design Institute Group Ltd. ; Chapter 13 was under the responsibility of Zhou Lequn, Yao Junhu, Li Pingzhi, Wu Yuhua, Yuan Dengwei, Hu Zongyun and Gao Gaiping from Changjiang Reconnaissance Technology Research Institute, Ministry of Water Resources and Changjiang Soil and Water Conservation Monitoring Center, Changjiang Water Resources Commission, Ministry of Water Resources; Chapter 14 was modified by Dai Wenhan from Shaanxi Provincial Highway Survey and Design Institute; Chapter 15 was under the responsibility of Yu Shiyong from Research Institute of Petroleum & Development; Chapter 17 was under the responsibility of Yun Caixing from East China Normal University. Chapter 18 was under the responsibility of Yang Rihong from China Aero Geophysical Survey & Remote Sensing Center for Land and

Resources (AGRS). On the occasion of republication, we would like extend our gratitude to everyone mentioned above. Many people participated in writing this book. But owing to the limitations of our knowledge, there must be omissions and improper descriptions. We hope that the readers will kindly point out our errors.

Publishing and Authors
June,2011

前 言

此书是对我国近半个世纪积累的遥感工程地质判释经验和应用情况的总结,同时简要地介绍了遥感技术及其当前的最新进展情况。通过本书的内容介绍,目的是使读者对当前遥感技术的最新进展情况及我国遥感工程地质应用情况有所了解,从而为推动我国遥感工程地质应用,尽微薄之力。

本书可以说是《遥感原理和工程地质判释》(中国铁道出版社,1982年)的姊妹篇,书中内容包括遥感信息技术简介、遥感图像工程地质判释、遥感技术在各种工程的地质调查中的应用等三部分。其中,遥感信息技术只作简要介绍,主要介绍遥感技术发展的最新动态,包括遥感信息获取的最新进展以及遥感图像处理、地理信息系统等;遥感图像工程地质判释是本书的主要内容,重点是对遥感判释理论进行了系统总结,并详细地叙述了遥感工程地质判释技巧和经验,同时结合大量珍贵的地质遥感典型图谱对工程地质判释进行详细的叙述;遥感在各种工程地质调查中的应用更是本书的重点内容,大量介绍了遥感技术在铁路、水利、公路、油气管道、电力和港口等工程地质调查中应用的实例。其中第三部分遥感技术在各种工程的地质调查中的应用,在目前国内同类书中未见介绍过,是遥感工程地质应用的最新成果总结,可以说是本书的特点所在。

鉴于目前卫星遥感图像和可见光黑白航片(简称航片)在实际应用中最为普遍,其他航空遥感图像应用的较少,尤其在工程勘测应用中以航片为主,故本书重点介绍可见光黑白航片的判释,其他遥感图像只简略介绍其特有的判释特点,不作详细介绍,因为掌握了可见光黑白航片判释标志和技巧后,其他遥感图像的判释也就比较容易了。

全书共十六章约100万字,图像300余张(像对),各章节的编写分工如下:第一章~第二章由北方交通大学吴景坤编写;第三章~第十一章由铁道部专业设计院卓宝熙编写;第十二章由铁道部专业设计院卓宝熙、中国铁路工程总公司李海明编写;第十三章由水利部长江勘测技术研究所周乐群、李平治、吴玉华、袁登维、胡宗云,铁道部专业设计院卓宝熙编写;第十四章由交通部第二公路勘察设计研究院许也平,铁道部专业设计院卓宝熙编写;第十五章由中国石油勘探开发研究院王世洪、殷利甫编写;第十六章由国家电力公司遥感中心柴渊编写。

本书编写过程中得到铁道部专业设计院和全国地方遥感应用协会的大力支持。水利水电部的金亨丁、李建雄、王礼育、欧作畿、罗章成,国土资源部遥感中心的丁富海,交通部第一公路勘察设计研究院的刘世丰,中国石油天然气管道工程有限公司的周亮臣、王卫民等为本书提供了许多有价值的资料。铁道部专业设计院戈清萍、甄春相、胡清波、李振东、李光伟、吴为禄、王艳华、赵俊霞协助搜集资料,核对书稿、绘图等工作,此外,还得到该院航测遥感处遥感应用研究所及文整中心有关同志的鼎力相助。在此一并向上述单位和个人表示衷心的感谢!

本书编写时还参考利用了铁道部专业设计院遥感地质老专家积累的一些资料,遥感学术会议论文集,未正式出版的科研成果和资料,未在参考文献中列出,在此也向这些作者表示感谢。

由于编著者水平所限,书中内容难免有疏漏和不妥之处,恳请同仁不吝指正,以臻完善。

编著者
2001 年 12 月

Foreword

The book summarizes China's experiences and applications of geological remote sensing interpretation for nearly half a century, and briefly introduces remote sensing Technology and their up-to-date development. The purpose of the book is to let readers know how remote sensing techniques have developed lately and how they are applied in engineering geology by China. It is hoped that this book makes a little contribution to promoting such applications.

The book can be considered as the companion volume of Remote Sensing Principle and Interpretation of Engineering Geology published by China Railway Publishing House in 1982. Three parts are incorporated in this book, including "Introduction of Remote Sensing Information Technology", "Interpretation of Engineering Geological Remote Sensing Images", and "Application of Remote Sensing Technology in Different Cases of Geological Investigation". It briefly introduces remote sensing information technology, and focuses on latest developments in remote sensing Technology, including state-of-the-art remote sensing information acquisition, remote sensing image processing, geographical information system, etc. Interpretation of remote sensing images in engineering geology is the key part of this book. This part systematically concludes remote sensing interpretation theories, and details relevant skills and experiences. Lots of typical invaluable maps drawn by geological remote sensing are used to elaborate interpretation of engineering geology. Most important of all is the application of remote sensing Technology in different cases of geological investigation. A great number of practical examples, in the fields like railway, irrigation, roadway, oil-gas pipe, power, and harbors, are used to introduce how this Technology is applied. The third part, describing the application of remote sensing Technology in different cases of geological investigation, hasn't been seen in similar books from our country before. It is the latest conclusion of the achievements obtained in geological remote sensing application, and can be deemed to be the feature of this book.

At present, remote sensing satellite images and visible-light black-and-white aerial photographs (aerial photography for short) are most common in practice, and other kinds of remote sensing aerial photographs are seldom used. Aerial photography plays a major role in engineering survey application. So, this book highlights the interpretation of visible-light black-and-white aerial photography. For other kinds of remote sensing images, distinctive characteristics of interpretation are briefly introduced. One can easily understand them if he masters the skills of interpreting the symbols used in visible-light black-and-white aerial photography.

This book is divided into sixteen chapters. In all, it comes to some 1,000,000 Chinese characters and collects about 300 images (image pairs). These chapters were written by: Wu Jingkun from Northern Jiaotong University, responsible for Chapter 1 - 2; Zhuo Baoxi, from Professional Design Institute for Ministry of Railway, responsible for Chapter 3 - 11; Li Haiming from China Railway Engineering Corporation, together with Zhuo Baoxi, responsible for Chapter 12; Zhou Lequn, Li

Pingzhi, Wu Yuhua, Yuan Dengwei, and Hu Zongyun from Changjiang Reconnaissance Technology Research Institute of Ministry of Water Resources, together with Zhuo Baoxi, responsible for Chapter 13; Xu Yeping from CCCC Second Highway Consultants Co., Ltd. Ministry of Communication, together with Zhuo Baoxi, responsible for Chapter 14; Wang Shihong and Ying Lifu from Research Institute of Petroleum & Development, responsible for Chapter 15; Chai Yuan from State Power Corporation, responsible for Chapter 16.

Professional Design Institute for Ministry of Railway and China Association of Remote Sensing Application gave us great support during the writing of this book. Jin Hengding, Li Jianxiong, Wang Liyu, Ou Zuoji, and Luo Zhangcheng from Ministry of Water Resources, Ding Fuha from China Aero Geophysical Survey & Remote Sensing Center for Land and Resources (AGRS), Liu Shifeng from CCCC First Highway Consultants Co., Ltd. Ministry of Communication, Zhou Liangchen and Wang Weimin from China Petroleum Pipeline Engineering Corporation provided much useful information. Ge Qingping, Zhen Chunxiang, Hu Qingbo, Li Zhendong, Li Guangwei, Wu Weilu, Wang Yanhua, and Zhao Junxia from Professional Design Institute for Ministry of Railway helped us with collection of materials, checking of drafts, and mapping. Furthermore, we also received great support from their colleagues who work at Research Institute of Remote Sensing Application, Aerial Survey & Remote Sensing Department, and at the Document Management Center. Here, I would like to express my sincere gratitude to everyone mentioned above!

Some materials accumulated by veteran experts specializing in geological remote sensing from Professional Design Institute for Ministry of Railway, in addition to paper collections of remote sensing academic conferences, and unpublished scientific research achievements and documents, were referred to when preparing this book but not included in the list of references. I wish to take this opportunity to thank you all.

Owing to the limitations of our knowledge, there must be omissions and improper descriptions. We hope that the readers will kindly point out our errors.

Authors
December 2001

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