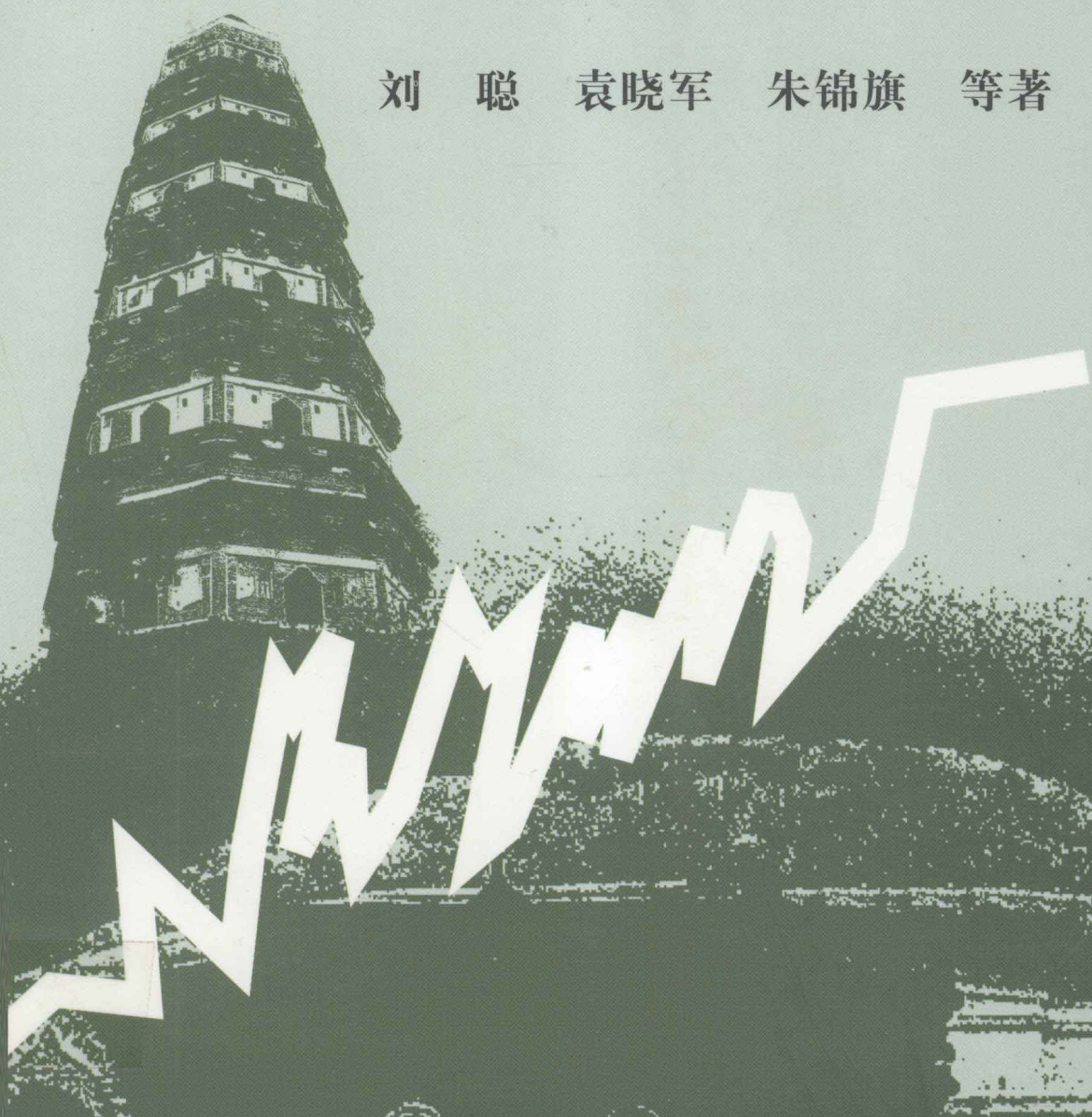


# 苏锡常地裂缝

刘 聪 袁晓军 朱锦旗 等著



中国地质大学出版社

国土资源大调查项目资助

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刘 聪 袁晓军 朱锦旗 等著

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## 内 容 简 介

本书介绍了苏锡常地裂缝形成、发展和破坏特征,在分析了地质背景、特别是人类社会工程经济活动的基础上,指出了控制地裂缝形成和发展的主要因素,同时,侧重地裂缝的勘查及预测方法技术介绍。本书可供从事地质灾害防治的勘查、科研和教学工作者参考。

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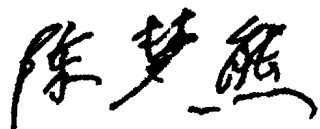
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# 序

随着国民经济的发展，资源环境的矛盾日益突出，特别是对资源环境可持续发展缺乏足够的认识，致使人类赖以生存的地质环境遭受一定程度的破坏，导致生态环境失去平衡，产生了一系列地质灾害，如水土侵蚀、地面沉降、岩溶塌陷、地裂缝、滑坡、崩塌、泥石流等，给经济发展和人民生命财产带来了一定的损失，特别是由于过量开采地下水导致的地面沉降、地裂缝灾害先后在西安、大同等城市出现，引起了广大水文地质、工程地质工作者的关注和研究，由此推动了灾害地质学这一学科的发展。

自20世纪80年代以来，苏锡常地区由于国民经济持续高速发展，导致地下水资源过量开采，诱发了一系列地质灾害，如地面沉降、地裂缝等，给社会造成了不安定因素和负面影响。水文地质、工程地质科技工作者，对该地区地裂缝灾害的形成机制进行了深入的研究，特别是江苏省国土资源厅地质调查研究院，自20世纪90年代开始，就有目的、有计划、有针对性地对区内25处地裂缝进行了分类型详细勘查。从地裂缝的表面现象到地裂缝的形成机制，从地裂缝的初步勘查到各种方法综合应用，从地裂缝的发生、发育规律到地裂缝的预警区划分和防治决策都进行了深入研究，取得了丰硕成果。

《苏锡常地裂缝》一书的出版，是多年来对苏锡常地区地裂缝的勘查和研究的高度总结，是对水文地质、工程地质、环境地质学科发展的重要贡献，为苏锡常地区国民经济的可持续发展奠定了地质环境基础。



2004年8月7日  
北京

# 前 言

有关地裂缝灾害的记载可上溯至 15 世纪,据《陕西通志》:“1486 年咸宁地裂,倾陷民房墙垣无数。”清《今古图书集成》地异部记载:“明成化 22 年(1501 年)6 月咸宁县地裂,倾陷民房墙垣无数。”记述中俗称的地裂应是目前地学界统称的地裂缝,反映出灾害破坏性较大。自陕西西安 20 世纪 50 年代末出现地裂缝以来,河北、山东、广东、河南等省亦相继发生,到 2003 年全国共发生地裂缝灾害 500 多处,涉及十多万省。西安地裂缝因其规模大及发生早,研究工作已进行了数十年,相关研究成果相当丰富。

苏锡常地区地裂缝灾害于 1998 年于常州市武进县横林镇“猝然出现”,其后呈高速蔓延,短短十多年间即发生 20 多处,涉及 5 县 17 乡镇,房毁路裂、管断桥倾,直接经济损失数亿元,给当地经济建设和社会稳定带来不利影响。

国外地裂缝研究尤其是美国亚利桑那州地裂缝,引世人注目。限于人类工程活动方式、能力及认知程度,早期没有把地裂缝与开采下伏地下水联系起来,仅将它与地震事件相关联(Leonard, 1929)。因此最早研究地裂缝的是地震地质部门,认为构造运动(蠕变)是主因;20 世纪 50 年代以来(Feth, 1951)提出和地下水抽汲有关的局部不均匀压实机理后,各国水文地质工作者逐渐在地裂缝勘查中作出了自己的贡献。国内地下水的开发利用起步于 20 世纪 60 年代及 70 年代,进入 80 年代后,由于国民经济的迅速发展及城市化进程的明显加快,人类对水资源尤其是对洁净地下水资源的需求倍增,在很多城市产生了区域地下水位降落漏斗,反映出人类对地质环境的扰动加剧,地质环境原有的相对平衡已被打破并寻求新的平衡,地裂缝的出现便是“反映”之一。随着地球物理探测和大地测量技术的应用,地裂缝勘查大大前进了一步,而且为减灾提供了重大帮助。

苏锡常地裂缝出现的初始阶段,由于缺乏经验和勘探、监测资料,曾存在有“新构造运动说”、“差异地面沉降(第四系压缩)说”的激烈争论,有的认为地裂缝的出现与地基处理失当有关,甚至与 1991 年特大水灾挂钩。从 20 世纪 90 年代开始,我们开始关注苏锡常地裂缝灾害,并首次针对江阴河塘地裂缝进行灾害表象特征调查,辅之以一定的勘查工作量,运用排除法的思路,初步认定地裂缝是特定地质背景下地下水强烈开采诱发所致;其后,又陆续在其他 8 处做了专项调

查，并承蒙中国地质环境监测院哈承佑、王瑞久等多位先生的指导，进一步完善了对苏锡常地裂缝成因类型归纳及触发条件的认识，并摸索出一套行之有效的外业调查及勘查方法。1999年后，江苏省国土资源厅、中国地质调查局又联合出资，由江苏省地质调查研究院承担了全区性的地质灾害勘查工作，该项成果2000年被省政府办公厅采纳，并专门为此发文有关县市政府，指导地方政府建设规划。该项成果提高了对全区地裂缝灾害特征、分布及赋存条件的认识，并且提出了全区性地裂缝易发区预测，不仅为日后实践印证，而且为防灾、减灾提供了科学指导。

回顾过去15年来对苏锡常地裂缝灾害的研究经历，一方面我们做了大量地裂缝灾害调查、地球物理勘察等多种方法的实践，积累了比较丰富的实践经验；另一方面借鉴了国内外研究成果和同行专家的指导，才有条件编著本书。在此，对此付出劳动的有关专家表示衷心感谢。

全书由江苏省国土资源厅刘聪博士主编，江苏省地质调查研究院具体组织，刘聪、袁晓军、朱锦旗负责总体大纲设计、统编、修改和校核全稿。具体写作分工如下：前言由袁晓军、朱锦旗编写；第一章由徐玉琳编写；第二章第一节、第二节由朱锦旗、余勤编写，第三节由郭盛乔、阎长虹教授（南京大学）、毕葵森编写；第三章由宗开红编写；第四章由于军、武健强编写；第五章由刘聪、朱锦旗、宗开红编写。陈杰、金永念参与了编写工作；李菊负责初校，张于负责图件整饰；陆李萍负责内容简介、前言以及目录的翻译工作。

在本书编写过程中始终得到中国地质调查局水环部殷跃平博士及江苏省国土资源厅地质环境管理处崔德庚处长、倪红升副处长的大力支持与鼓励，黄金生、方家骅、吴士良、朱兴贤、姚炳魁、伍洲云等同志的相关研究成果及认识对本书的编写帮助颇大，尤其本书得以出版，依赖于江苏几代地矿工作者辛勤的工作，在此一并致谢。

本书编写过程中，承蒙中国地质环境监测院的哈承佑研究员对本书进行了详细的审稿，并给编写组提出了许多卓有见地的意见和资料支持；资深院士陈梦熊先生更是不顾年事已高和高温酷暑，热情地为本书作了序，在此致以深深的谢意。囿于编写者水平及工作范围所限，书中谬误难免，敬请读者批评指正。

# Preface

The geological disasters in record can be traced back to the 15<sup>th</sup> century. According to the General Annals of Shaanxi: 'In 1486, an earth crack took place in Xianning, causing the collapse of numerous local houses'. Collection of Modern and Ancient Books of Qing Dynasty said that 'In June, 1501, an earth crack took place in Xianning County, leading to a break down of numerous local houses'. The earth cracks locally recorded should be the earth fissures named in modern geosciences. Since the emergence of earth fissures in Xian in the end of fifties in 20<sup>th</sup> century, Provinces such as Hebei, Shandong, Guangdong and Henan followed in concession, more than 500 sites of earth fissures emerged all over the country when it approached the year 2003, involving over ten provinces. As it was the earliest case and largest in size, the studies on Xian earth fissures have been conducted for tens of years and the related research results are rather abundant.

The earth fissures in Su-Xi-Chang came forth in 1998, with an unexpected emergence, an earth fissure occurred in Henglin Town of Wujin County, Changzhou City. Thenceforth, the disaster expanded rapidly, more than 20 sites in the subsequent ten years, involving five counties and seventeen towns, destroying roads, bridges, pipes and houses and so on, bringing adverse effect to the local economic construction and social stability, bringing forth challenges to the geologists in Jiangsu Province.

Study on the earth fissures abroad, with earth fissures in Arizona State in USA in particular, have aroused world attention. Limit to the engineering activity mode, ability and cognition extent, and the formation of earth fissures was merely linked with seismic event other than the extraction of groundwater water. In this case, the seismic department became the earliest in the study of earth fissures, considering that the main cause was tectonic (creep) movement; since the 50's in the 20<sup>th</sup> century, the theory of local uneven compaction mechanism



related with groundwater extraction was advanced, the hydrogeologists all over the world have made their own contributions to the investigation of earth fissures gradually. The exploitation of groundwater in China started in the 60's and 70's in the 20<sup>th</sup> century. After the 80's, the demand for the clean groundwater multiplied, causing cones of depression for regional groundwater level in many cities. Being disturbed intensively by the mankind, the original balance of the geological environment has been broken and seek for a new balance is underway; hence, the emergence of the earth fissure is one of the reflections. Along with the application geophysical prospecting and geodetic survey, the technology of earth fissure prospecting has been greatly promoted, offering a great help to the reduction of disasters.

Owing to the shortage of experience and data of prospecting and monitoring during the initial stage of earth fissure occurrence in Su-Xi-Chang, vehement disputes were existent among different departments on the origin of earth fissures, like the theories of 'Neotectonism', 'Differential ground subsidence (Compression of Quaternary system)'; some considered the occurrence was related with the improper treatment of ground foundations, some even linked the earth fissure with the flood in 1991. In 1990, we started to focus the disasters taken place in Su-Xi-Chang, the first investigation was carried out in Hetang, Jiangyin County, aiming at the superficial features of the fissures, the fixed year of the crazed buildings and roads and cognized elementary that the fissure was induced by an extensive extraction of groundwater; thereafter, a special survey in eight sites was conducted in succession. Under the guidance of Prof. Ha Cheng-you and Wang Rui-jiu, the summarization of the origin types of the earth fissures occurred in Su-Xi-Chang and their burst conditions was made more perfect, a set of effective field survey and prospecting methods had been felt for. After 1999, under a joint support of the Department of Land & Resources and China Geological Survey, Geological Survey of Jiangsu Province undertook a project of regional geological disaster investigation; the provincial government in 2000 adopted the results of the Project, and dispatched to the local governments to guide their local construction and planning. The results of the Project improved the knowledge of the earth fissure characteristics, distribution

and hosting conditions, advanced the prognosis of regional incidental areas, which was not only verified by the later practice but also served as a scientific guidance for the prevention and reduction of the disasters.

Looking back the experience in the study of earth fissure in the past fifteen years, we did a great deal of work in the investigation of earth fissure disaster and geophysical prospecting, piling up some rich field experience, on the other hand, with the reference of the research achievements both home and abroad and under the guidance of the experts, the monograph is published, here heartfelt thanks will be given to the concerned experts who offered their efforts for the compilation of the monograph.

Dr. Liu Cong, from the Department of Land & Resources, is the chief editor for the monograph; the Geological Survey of Jiangsu Province organizes the specific affairs, and the monograph falls into six parts. Liu Cong, Yuan Xiao-jun and Zhu Jing-qi are responsible for the design, whole compilation, emendation and correction of the overall outline; the preface is written by Yuan Xiao-jun and Zhu Jing-qi; Chapter I is written by Xu Yu-lin; section I and II in Chapter II are written by Zhu Jing-qi and Yu Qin; Section III in Chapter II by Guo Sheng-qiao, Prof. Yan Chang-hong (Nanjing University) and Bi Kui-sen; Chapter III is written by Zong Kai-hong; Chapter IV is written by Yu Jun and Wu Jian-qiang; Chapter V is written by Liu Cong, Zhu Jing-qi and Zong Kai-hong. Chen Jie and Jin Yong-nian participated in the compilation; Li Ju undertakes the elementary collation; Zhang Yu undertakes the clear up of charts and illustrations; Lu Li-ping undertakes the translations of the Brief Introduction, Contents and Preface.

The compilation has been always supported and encouraged by Dr. Yin Yue-ping from China Geological Survey, and Division Chief Cui De-geng, Associate Division Chief Ni Hong-sheng from Jiangsu Department of Land & Resources. The experts for their devotion of related research achievements have given much help for the compilation, they are: Huang Jin-sheng, Fang Jia-hua, Wu Shi-liang, Zhu Xing-xian, Yao Bing-kui and Wu Zhou-yun; the efforts made by the geologists of several generations are the solid foundations for the publishing of the monograph. Hereon, all the thanks will be given to them.

In the course of the compilation, Researcher Ha Cheng-you, from the

Monitoring Institute of China Geological Environment, made a detailed revision and offered many constructive suggestions and data support; senior academician Chen Meng-xiong wrote the prelude. Special thanks will be sent here. Limit to the compiling level and range of operations, errors and mistakes are hard to avoid in the book, and any comments and corrections are welcome.

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