中国震例

EARTHQUAKE CASES IN CHINA

(1986－1988)

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内 容 提 要

《中国震例》系列书是研究地震和探索地震预报的重要科学资料。本书前3册系统总结了中国大陆地区1966～1985年发生的60次5级以上地震，汇编成58个震例研究报告，已于1988年和1990年分一、二、三册出版。本册（第四册）收录了28个震例报告，其中1986～1988年25个，增补1967～1985年3个。每个震例报告大体包括摘要、前言、测震台网及地震基本参数、地震地质背景、烈度分布及震害、地震序列、震源机制解和地震主破裂面、观测台网及前兆异常、前兆异常特征分析和总结与讨论等基本内容。本书是以地震前兆为主的系统的、规范化的震例研究成果，文字简明，图表清晰，便于查询、对比和分析研究。

本书可供地震预报、地球物理、地球化学、地质、工程地震等领域的科技人员、大专院校师生及关心地震灾害的读者使用、研究和参考。

Synopsis

The multi–volume series book of "Earthquake Cases in China" contains important scientific data and information for seismological studies and earthquake prediction researches. The first three volumes has systematically summarized 60 earthquakes of $M_S \geqslant 5$ which occurred in the Chinese mainland from 1966 to 1985, with 58 research reports of earthquake cases to be published in 1988 and 1990. This volume (Volume Ⅳ) compiled 28 resarch reports of earthquake cases including 25 reprts of cases occurred from 1986 to 1988 with supplement of three reports of cases occurred from 1967 to 1985. Eachcase report includes abstract, introduction, seismometric network and basic parameters of an earthquake, seismogeological background, seismic intensity distribution and earthquake damages, earthquake sequence, focal mechanism solutions and main fault plane, monitoring network and precursory anomalies, characteristic analyses of precursory anomalies, summary and discussions. The Book includes the research accomplishments obtained from the systematic and standardized studies of earthquake cases with the data on earthquake precursors as main components. Simple and concise illustration and distinct figures and tables are used for readers to consult, compare with and analyse conveniently.

The Book is useful, helpful and referential for scientific and technical workers and teachers and students from higher learning schools in earthquake prediction, geophysics, geochemistry, geology, engineering seismology, and personnel who are interested in seismic hazard reduction.

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编 写 说 明

中国地震前兆的观测和预报实践从1966年邢台地震开始，已走过30多年的历程，取得了显著的进展。地震预报是以观测为基础的科学。短临预报是地震预报的主要目标，实现它的重要环节是获取可靠的地震前兆资料，通过综合分析，进而进行地震发生时间、地点和震级三要素的预报。因此，全面地积累每次地震的地震地质、震害、地震参数、地震序列，尤其是地震前兆及预测预报的经验教训等资料，对于地震科学研究、地震预报和防震减灾具有特别重要的科学价值。经过研究整理的一次或一组地震的上述系统资料，本书中称之为震例研究报告，它们是地震预报和研究的基础。

1966年以来我国大陆发生了众多的5级以上地震，其中的许多地震已有不少论文和专著，但由于没有统一的规范和要求，有关资料不便进行系统的综合分析对比。为了系统地研究地震前兆和推进地震预报工作，国家地震局（现为中国地震局，以下同）于1986～1987年安排了我国大陆1966～1985年5级以上地震的研究项目，作为该研究的成果，《中国震例》系列书三册于1988年和1990年出版，含58个研究报告，系统地研究总结了60次地震。1992年起国家地震局安排了1986～1991年第二批震例的研究，进行了许多研究工作，共完成56个震例研究报告，将在《中国震例》第四和第五册中出版。本册（第四册）收录了28个震例研究报告，包括1986～1988年25个，增补前三册中未辑入的1967～1985年3个报告。

本系列书以地震震例研究报告集的形式按地震发生日期顺序编辑成册。本册继承了前3册的基本要求和规定，并稍作修订。各报告按以下基本章节内容进行编写：

一、摘要

概述报告的主要内容。

二、前言

给出主震或重要地震的发震日期、震害、预测预报、宏观考察和研究历史等总体情况。

三、测震台网和地震基本参数

给出地震前震中附近测震台网情况和主震或重要地震的基本参数。对同一地震，当不同单位给出不同参数时，则分别列出，编写人认为最合理的参数放在第一条。

四、地震地质背景

简要介绍震中附近地区的区域大地构造位置、深部构造条件、区域形变场概貌、历史地震活动及主要构造与断裂的活动性，以及与发震构造有关的资料。

五、烈度分布与震害

给出烈度分布图、宏观震中的地理位置。简要介绍等震线范围、重要地表破坏现象、烈度分布特征及震害评估结果。

六、地震序列

尽可能给出全序列资料（包括直接前震和余震的有关参数），余震震中分布图，地震序

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列类型，应变释放曲线或能量衰减曲线图，序列 b 值，频度衰减系数及较大余震目录等。

七、震源机制解和地震主破裂面

分别给出震源机制解图和表。对同一地震，如有不同的解，则分别列出，编写人认为最合理的解列在表中第一条。综合分析地震主破裂面与发震构造的关系。

八、观测台网及前兆异常

介绍地震前的定点前兆观测台网及其他有关观测情况。规定 $M_S \geqslant 7.0$ 地震距震中 500 km，$6.0 < M_S < 7.0$ 地震距震中 300 km，$5.0 < M_S < 6.0$ 地震距震中 200 km，作为定点观测台网前兆资料的统计范围。分别给出此范围内测震台以外的其他地震前兆定点观测台站（点）或观测项目分布图，以及前兆异常项目平面分布图。认为与此次地震孕育过程有关的全部前兆异常，包括非定点台网观测到的异常和上述规定距离以外的重要异常，均列入前兆异常登记表，并给出前兆异常图件。概述前兆异常的总体情况，以图表为主，必要时加以简要文字说明。对所有台站（点）的所有观测项目或异常项目进行累加统计时，其统计学单位称为台项。

为保证资料的可靠性，要求所用数据的观测质量必须符合观测规范，且能够区别正常动态与异常变化。观测资料质量划分为三类：1 类——符合上述要求；2 类——基本符合；3 类——不符合。规定只选用 1、2 类观测资料，3 类资料不予使用，亦不进入统计。异常判定应经过全部资料和全过程的分析，经排除干扰和年变等因素后，根据一定的判据，认定与地震关系密切的变化才列入异常登记表。

规定按时间发展进程把异常分为 L、A、B、C 四个阶段类别：L——长期趋势背景异常，出现在地震前 5 年以上；A——中期趋势背景异常，出现在震前约 0.6～5 年；B——短期趋势异常，震前延续约 1～6 个月；C——临震异常，震前大约 1 个月内。另外，对远离规定的震中距范围以外，或据现有认识水平一时无法解释，以及非常规观测的、值得研究的其他可靠和较可靠的异常现象划为 D 类，以留下资料和记录。对 L、A、B、C 类异常，按照其可信程度，又区别为Ⅰ、Ⅱ、Ⅲ三个等级，以下角标标示：Ⅰ——可靠；Ⅱ——较可靠；Ⅲ——参考，留作记录。D 类异常只取Ⅰ和Ⅱ两类。如：$C_{Ⅱ}$ 为较可靠的临震异常；$DA_{Ⅰ}$ 为可靠的中期 D 类异常。关于Ⅰ、Ⅱ、Ⅲ等级的确定，主要尊重编写人的意见，编辑过程中仅作了个别调整，供读者参考。宏观异常在登记表中总的作为一项异常供研究。为了减少异常数量统计工作中的随意性，规定异常虽超过 1 个月，但不足 1.5 月者仍算临震，虽超过 6 个月、不足 6.5 月者仍算短期。异常登记表中各栏目，既是编写人对异常研究的结果，亦是为了给读者提供使用、研究和参考的方便。对异常进行以上的认真审核和分类处理的结果，既可达到去粗取精、去伪存真的目的，又可避免丢失可能有科学价值的异常记录，以利于进一步研究和资料积累。尽管如此，书中辑入的异常未必都恰当，读者可根据提供的资料和文献进一步做出判断。

全书对异常登记表中使用的观测手段（异常项目）名称及图件中的常用图例作了统一规定。

九、前兆异常特征分析

简要给出对主要异常特征的综合分析与讨论，提出有依据的看法和待研究的问题。

十、总结与讨论

从科学和实践上讨论取得的经验、教训、学术观点和问题。

十一、参考文献和参考资料

给出在震例研究和报告编写工作中研究过的全部文献和资料目录。报告中直接引用已出版文献或未出版的参考资料、图件和工作结果时均应注明来源，以便读者进行核对或追踪研究。

对于已发表有专著的强震，根据专著发表后的研究成果，亦按以上要求编写震例报告，并进行必要的资料补充，专著中发表过的异常图件一般从略，文字从简。

本书辑入的震例报告是前人和编写人对该次震例资料整理和研究成果的集中表达，是以地震前兆为主的系统的、规范化的震例科研成果。《中国震例》编辑组工作的指导思想是：经过科学整理和研究，给出各次地震的基本资料，既可供读者使用、参考，又可供进一步追踪研究；既具有资料性，又反映目前研究程度；文字力求简明，避免冗长的叙述和讨论，因此尽量使用了图表，便于对比。由于资料和研究程度的差异，各报告在坚持质量和科学性的前题下，根据实际情况编写和编辑，因此篇幅和章节编排不尽一致。

中国大陆地震前兆的观测与预报实践表明，地震的孕育和发生是一个极其复杂的过程，影响因素很多，伴随这一过程有许多异常现象，我们把那些与地震孕育、发生过程相关联的有别于正常变化的异常变化称之为地震前兆，即采用广义地震前兆的概念。本书辑录的前兆异常，是经过审核的与地震孕育、发生过程有关联的异常现象，其中既可能有区域构造应力场增强引起的异常("构造前兆")，又可能有来自震源的信息("震源前兆")，具有不同的前兆意义，无疑包含着丰富的前兆信息。因而震例研究报告是地震前兆研究和预报探索的宝贵财富，它既是进一步研究的基础资料，又可供在今后震情判定中借鉴。需要指出的是，震例报告是震后经过若干年的资料收集、发掘、整理和总结研究之后编写的，从震后总结到实现震前的科学预报，还要经过一段艰难的路程。

国家地震局于1986～1987年安排了"我国大陆5级以上震例的再研究"重点研究项目，为了统一标准，制定了《地震震例报告编写规范》。此次工作过程中又进一步修订为《震例研究和报告编写规范》，在地震系统中试行，并指导本书震例的研究和报告的编写。震例报告是震例研究的成果。报告对前人的工作，特别是地震前兆研究的成果，虽尽力作了反映，但由于人员变动和资料收集的困难，以及水平限制等原因，难免仍会有疏漏，对个别异常和资料的处理亦可能会有不妥之处。

震例的研究和报告的编写及本书的编辑、出版，得到了国家地震局、分析预报中心、有关省、自治区地震局（办）和地震出版社领导、有关部门和朋友们的大力支持和帮助，作者和编者在此表示衷心感谢。

本批震例的研究和报告的编写工作由国家地震局预测预防司具体组织，共有16个单位参加，包括13个省和自治区地震局及2个地方局，国家地震局分析预报中心为负责单位。各单位的项目负责人是：分析预报中心张肇诚、郑大林；黑龙江省地震局陈兆英；河北省地震局黄保大；山西省地震局赵新平；内蒙古自治区地震局许建德；江苏省地震局贺楚儒；福建省地震局杜运连；四川省地震局程万正；云南省地震局陈立德；甘肃省地震局郭大庆；新疆维吾尔自治区地震局王海涛；宁夏回族自治区地震局张文孝；青海省地震局张晓东，直接参加报告编写的人员共有54人。

本书的编辑工作由《中国震例》编辑组完成。主编——张肇诚；副主编——郑大林、徐京华；编辑组成员——张肇诚、郑大林、罗平、汪志亮、王贵宣；陈尚平、张炜对英文

图、表名进行了译校工作；宋喜先帮助进行了录入和排版；李晓玲、康小林参加了部分校对工作；书中图件由地震出版社彭娅玲、孙铁磊等进行了加工和清绘。编辑组虽然作了很大努力，但由于水平和条件所限，书中可能还有不周或不足之处，望予谅解并提出宝贵意见。

编　者

1998 年 12 月，北京

About This Book

In China, observational work of earthquake precursors and earthquake prediction practices have gone through 30 years or more substantial developments since the Xingtai earthquake of 1966. Earthquake prediction is a science which mainly based on observation data. The principal goal of earthquake prediction is to make short term to imminent prediction of the time, magnitude and place of an earthquake. It is clear that we can only achieve such prediction based on reliable data on earthquake precursors and their accurate analyses. Therefore, it is of particularly important scientific value to accumulate overall data on seismogeology, earthquake damages, earthquake parameters, earthquake sequence and especially earthquake precursors and prediction status of an earthquake for earthquake research, prediction, protection, and hazard mitigation. The above-mentioned systematic data of an earthquake or a group of earthquakes, which is the basis for earthquake predictions and researches, are treated as a research case report in this publication.

Many earthquakes of $M_S \geq 5.0$ occurred in Chinese mainland since 1966. Numerous papers and works on many earthquakes have been already published, but due to absence of unified standards and requirements, systematic and comprehensive analyses and comparisons can not be done on many relevant data. In order to undertake comprehensive studies of earthquake precursors and to promote earthquake prediction research, the State Seismological Bureau (Now the Chinese Seismological Bureau) launched a research project during 1986~ 1987 on a series of earthquakes with $M_S \geq 5.0$ happened in Chinese mainland between 1966~ 1985. As a result, three volumes of Earthquake Cases in China were published in 1988 and 1990, containing 58 research reports covering 60 earthquake events. In 1992, the State Seismological Bureau initiated further research on the second batch of earthquakes happened between 1986~ 1991 with $M_S \geq 5.0$ in Chinese mainland. Since then, much more researches were done and 56 research reports were collected. We have decided to publish these cases in Volume Ⅳ and Ⅴ of Earthquake Cases in China, and this volume contains 28 reports, including 25 cases occurred from 1986 to 1988, as well as three cases occurred from 1967 to 1985 that were not included in the first three volume.

The book is compiled in the form of reports of earthquake cases and in order of dates of occurrences of the earthquakes. This Volume inherited the basic format of the first three volumes with some minor improvement. Each report contains the following basic components:

Abstract provides a summary of the major content.

Introduction describes the occurrence time of the earthquake, the earthquake dam-

ages, the prediction status, the macroscopic investigations and the history of earthquake studies, etc. of main shock or main earthquakes.

Seismometric Network and Basic Parameters of the Earthquake gives the distribution of seimometric network before events and the basic parameters of the main shock or main earthquakes. When the parameters of an earthquake determined by different institutions are different, they are listed separately, but the first one on the list is the parameters that the authors deem most reasonable.

Seismogeological Background provides a brief description of the regional geotectonic location, deep structure, regional deformation field, historical seismic activity around the epicenter, activities of main structures and faults, and other data associated with the earthquake-generating structure.

Distribution of Seismic Intensity and Damages illustrates the distribution of seismic intensity, the macroscopic epicenter in the name of the county, and in its longitude and latitude. The ranges of isoseismal lines and significant phenomena of surface destruction are described, the features of intensity distribution and the estimated earthquake damages are outlined.

Earthquake Sequence provides the whole sequence (including the relevant parameters of all direct foreshocks and aftershocks), the distribution of aftershock epicenters, the type of the sequence, the strain release curve or the energy attenuation curve, b-value of the sequence, the frequency attenuation coefficient, and the catalogue of major aftershocks when possible.

Focal Mechanism Solution and Main Fault Plane gives figures and tables of the focal mechanism solutions. When the solutions are determined differently, they are given separately, with the most appropriate one ranked the first by the authors. The comprehensive analyses are made on the relation between the earthquake fault plane and the earthquake-generating structure.

Monitoring Network and Precursory Anomalies describes the precursor monitoring network and other related observations. The statistical analyses are made on the precursory data obtained from the networks within the ranges of 500 kilometers distant to the epicenter of the M_S (7.0 earthquakes, 300 kilometers to the earthquakes of $6.0 < M_S < 7.0$, and 200 kilometers to the earthquakes of $5.0 < M_S < 6.0$. Provided also are the distribution map of fixed observation stations (points) or observation items (except seismometric item) within such ranges and the plane distribution of precursory anomalies (only indicating precursory items of fixed observations except seismic anomalies). All the anomalies that are closely linked with the process of the earthquake preparation, including the anomalies at non-fixed observation points and outside of the defined ranges, are listed in the summary table of precursory anomalies with corresponding figures. The overall situation of the networks and precursory anomalies are outlined, principally in the form of figures and tables, with concise illustrations if necessary. The statistic unit of observation

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items or anomaly items of all the stations (points) is called station-item.

In order to ensure the reliability of the data, the observation quality of the data were required to meet the observation standards and can distinguish between normal variations and anomalous changes. The quality of the observation data are classified into three classes: Type 1 —— meet the above mentioned quality requirements; Type 2 —— doesn't completely meet the quality standards but can still distinguish between normal variations and anomalies; Type 3 —— doesn't meet the requirements. It is decided that only the first two types of data can be used, while the third type will not be selected for statistical analyses. The anomalies are defined on the basis of the analyses result of all data and process after disturbances, annual variations, and other interfering factors removed. Thereafter, the anomalies judged to be closely associated with earthquakes are listed in the table.

The defined anomalies are divided into four classes L, A, B, and C according to the time the anomalies occurred: Class L indicates the long-term trend anomalies appeared over five years before the earthquake; Class A is the mid-term trend anomalies which occurred around six months to five year before the earthquake; Class B denotes the short-term trend anomalies which lasted for around one to six months before the earthquake; Class C means the imminent anomalies happened within approximately one month before the impending earthquake. We introduced a D class to capture certain reliable or fairly reliable anomalies that deserves further studies. They might come from observation stations that is rather far from the defined areas, can not be understand in nowadays knowledge, or are obtained from irregular observations. We further classified the anomalies according to their reliability degrees Ⅰ, Ⅱ and Ⅲ, with Ⅰ —— reliable; Ⅱ —— fairly reliable; and Ⅲ —— for reference. But for the class D are only classified in degree Ⅰ and Ⅱ. Reliability degree is marked in subscript to the right bottom of the class symbols. For example, $C_{Ⅱ}$ is fairly reliable imminent anomalies; $DA_{Ⅰ}$ is reliable mid-term anomalies. They are usually determined by the opinions of the authors, except a few adjustments were expressed by the editors for reader's reference. The macroscopic anomalies registered in the table are regarded as an item of anomalies for the purpose of this study. In order to standardize statistical study, one and half month and six and half month were used as the cut off point for imminent and short-term anomalies, respectively. Various items of anomalies registered in the summary table of precursory anomalies are the research results obtained by various authors and were provided for the convenience of the readers to utilize, study and refer to. The stringent evaluating and classifying processing of the anomalies not only serves the purpose of selecting the high quality data, but also helps avoid the possibility of losing any scientifically valuable recorded anomalies that are useful to further scientific research. However, the anomalies included in the book are not necessarily all appropriate, and readers should make further judgments based on the data and references provided.

The names of the observation items (anomaly items) and legend of figures are uni-

fied in the book.

Analyses of Features of Precursory Anomalies gives the comprehensive analyses and discussions of main anomaly features indicating authors interpretation based on observation data and their opinions on future research direction.

Discussions and Concluding Remarks explores the lessons learned, experience obtained, problem emerged, and academic viewpoints resulted based on science and practical experience.

References and Information lists all references and data which have been studied when conducting the case study. The origins of published and unpublished data, figures and working results which are directly quoted in reports are given.

Some strong earthquakes which have been studied in published monographs are also compiled as earthquake case reports, with necessary data supplemented. However, the published anomaly figures were generally avoided and illustrations were simplified.

Each of the earthquake case reports contained in this book mainly embodies the achievements gained by authors and others in sorting out and studying an earthquake case. They are the fruit of a systematic and standardized scientific research on earthquake cases with emphasis on precursors. The Editorial Board of Earthquake Cases in China was committed to ensure that this book will provide readers scientifically sound data on each earthquake for their reference and future research. Therefore, all reports are designed to have abundant information and clearly indicate the current research level. The literal illustrations are kept as simple as possible without lengthy descriptions and discussions, and figures and tables were given for comparison among cases. Each report is compiled and written to the highest possible quality and scientific soundness. However, owing to differences of data and research extent, the length and format for all reports are not exactly the same.

The earthquake precursory observation and prediction practice in Chinese mainland has shown that the preparation and occurrence of an earthquake are a rather complicated process which is influenced by many factors and accompanied by various anomalous phenomena. Taking the understanding for precursors in the broad sense, we call the anomalies that are closely linked with the process of the preparation and occurrence of an earthquake and distinct from the normal background of variations as precursors. The precursory anomalies included in the book are the examined and relevant phenomena associated with the process of earthquake preparation and occurrence. Among them may be both of anomalies caused by intensification of regional tectonic stress field (referred as "tectonic precursors") and the information from a single seismic focus (called as "focal precursors") . They have different precursory meaning, undoubtedly with rich precursory information involved. Therefore the earthquake case reports are the valuable wealth of studies of earthquake precursors and prediction, not only providing basic data for further investigations, but also contributing references for future assessments of earthquake tend-

ency. However, it should also be noted that those earthquake case reports are compiled through several years of collection, exploration, and summarizing of the data after the earthquakes, and there is a long and arduous way between post-earthquake summarization and scientific earthquake prediction.

During the period of 1986~1987, the State Seismological Bureau orchestrated an important research project entitled Reconsiderations of Cases of Earthquakes of MS over 5 in Chinese mainland. To standardize case reports, the Specifications for Compiling Earthquake Case Reports were formulated. In the process of working on the second batch of earthquake cases, the Specifications for Compiling Earthquake Case Reports were updated to the Specifications for Studying Earthquake Cases and Compiling Reports, which were used as guidelines for studying the earthquake cases and compiling the reports in this book. All efforts were made to ensure the reports reflected the high achievement of earthquake study in China in the past. However, due to personnel changes and limited data accessibility, inappropriate omission or improper processing of individual anomalies and data might have occurred.

Relevant leaders, leading bodies and many individuals from the State Seismological Bureau, the Center for Analysis and Prediction, SSB, Seismological Bureaus (Offices) of Some Provinces and Autonomous Regions concerned, and the Seismological Press, have rendered great supports and assistance in compiling the earthquake case report, as well as in editing and publishing this book. The authors and editors are very much grateful to all of them for their help which has made this book possible.

The Department of Forecasting and Preventing of State Seismological Bureau organized the studies on this batch of earthquake cases and the compiling work of reports. There are 16 institutions concerned taking part in this project, including 13 seismological bureaus of Provinces and Autonomous Regions and two local seismological bureaus with the Center for Analysis and Prediction, SSB, as the project manager. The responsible project personnels from these institutions are listed as follows: Zhang Zhaocheng and Zheng Dalin from the Center for Analysis and Prediction, SSB; Chen Zhaoying from Seismological Bureau of Heilongjiang Province; Huang Baoda from Seismological Bureau of Hebei Province; Zhao Xinping from Seismological Bureau of Shanxi Province; Xu Jiande from Seismological Bureau of Inner Mongolian Autonomous Region; He Churu from Seismological Bureau of Jiangsu Province; Du Yunlian from Seismological Bureau of Fujian Province; Chen Wanzheng from Seismological Bureau of Sichuan Province; Chen Lide from Seismological Bureau of Yunnan Province; Guo Daqing from Seismological Bureau of Gansu Province; Wang Haitao from Seismological Bureau of Xinjiang Uighur Autonomous Region; Zhang Wenxiao from Seismological Bureau of Ningxia Hui Autonomous Region and Zhang Xiaodong from Seismological Bureau of Qinghai Province. There are altogether 54 scientists who joined in efforts to compile these reports.

The editorial work is undertaken by the Editorial Board of Earthquake Cases in

China. Chief Editor —— Zhang Zhaocheng; Associate Chief Editors —— Zheng Dalin and Xu Jinghua; Members of Editorial Board —— Zhang Zhaocheng, Zheng Dalin, Luo Ping, Wang Zhiliang and Wang Guixuan. Chen Shangping and Zhang Wei have done the English translation and proof of the titles of figures and tables. Song Xixian have helped to input and compose the text of the book, and Li Xiaoling and Kang Xiaolin have done a portion of the proof work. All figures in the book are drawn or modified by Peng Yaling, Sun Tielei from the Seismological Press. Though great efforts were made by the editorial board, there might still be some improper aspects in the book due to our limited scientific level and time length. Therefore, any comments and corrections are greatly appreciated.

The Editorial Board

December 1998, Beijing

观测手段和异常项目名称一览表

观测手段	异 常 项 目 名 称
测　震	地震条带、地震空区（段）、地震活动分布（时间、空间、平静或增强）、前兆震（群）、震群活动、有震面积数（A 值）、地震活动性指标（综合指标 A 值，地震活动熵 Q^t、Q^N、Q^Σ，地震活动度 γ、S）、震级容量维（D^Q 值）、地震节律、应变释放（能量释放）、地震频度、b 值、h 值、地震窗、缺震、E、N、S 三项指标、诱发前震、前震活动、震情指数（$A(b)$）值、地震集中度（集中度 C、空间集中度 C_1、带状集中度 C_B）、η 值、D 值；小震综合断层面解、P 波初动符号矛盾比、地震应力降 τ，环境应力值 τ_0、介质因子（Q 值）、波速（波速、波速比）、S 波偏振、地震尾波（持续时间比 τ_H/τ_V、衰减系数 a、衰减速率 p）、振幅比、地脉动、地震波形；断层面总面积（$\sum(t)$）、小震调制比、地震缺信量（Iq）
地形变	水准测量（长水准）、定点水准（短水准）、流动水准、海平面；定点基线（短基线）、流动基线；地倾斜；断层蠕变
重　力	定点重力，流动重力
地　电	视（地）电阻率；自然电位
地　磁	Z 变化、幅差、日变低点位移、日变畸变；总场（总强度）、流动地磁；偏角
地下水	水氡、气氡、土氡（α 粒子径迹密度）、总硬度、水电导，气体总量、CO_2、H_2、He、N_2、O_2、Ar、H_2S、Hg、CH_4、SiO_2、Ca^{2+}、Mg^{2+}、Li^+、SO_4^{2-}、HCO_3^-、Cl^-、F^-；地下水位，地下水位与湖水位；水（泉）流量、水温
应力-应变	电感应力、钢弦应力；振弦应变、体积应变、压容应变
气　象	气温、气压、干旱、旱涝、大气电位
其他微观动态	石油井动态，地温，电磁波，长波辐射（OLR）
宏观动态	宏观现象
综　合	前兆信息熵（H）

The List of Observation Means and Precursor Items

observation means	precursor items
seismometry	seismic band, seismic gap (segment) , seismicity pattern (temporal, spacial, quiescence or activation) , precursory earthquake (or Swarm) , swarm activity, area of earthquake coverage (A value) , index of seismic activity (comprehensive index A; seismic entropy Q^t, Q^N and Q^{Σ}, degree of seismic activity γ and S) , fractal dimension of capacity D^Q, earthquake rhythm, strain release (energy release, earthquake frequency, b value, H value, seismic window, earthquake deficiency, E, N and S elements, induced foreshock, foreshock, exponential (A (b) value) of eathquake situation, seismic concentration (concentration degree C, spacial concentration degree C_1, band concentration degree C_B) , η values, D value of seismicity; composite fault plane solution of small earthquakes, symbolic contradiction ratio of P wave onsets, stress drop of earthquake, circumstance stress τ_0, quality factor (Q value) , wave velocity (wave velocity, wave velocity ratio, S wave polarization, seismic coda wave (sustained time ratio (τ_H / τ_V) , attanuation coefficient (a) , attanuation rate (p) , amplitude ratio, microseisms, seismic wave form; total area of fault plane ($\sum(t)$) , regulatory ratio of small earthquakes, seismic information deficiency (Iq)
deformation	leveling measurements (long leveling) , fixed leveling (short leveling) , mobile leveling, sea level; fixed base-line (short base-line) , mobile base-line; tilt; fault creep
gravity	fixed gravity, roving gravity
geoelectricity	apparent resistivity (ρ_s) , self potential (V_{SP})
geomagnetism	Z variation, Amplitude difference, low-point displacement of daily variation, distortion of daily variation; total intensity, roving geomagnetism; declination
ground water	radon in groundwater, escaping radon, soil radon (trace density of α particle) , total water hardness, water conductivity, total gas in groundwater, CO_2, H_2, He, N_2, O_2, Ar, H_2S, Hg, CH_4, SiO_2, Ca^{2+}, Mg^{2+}, Li^+, SO_4^{2-}, HCO_3^-, Cl^-, F^-; ground water level, ground water level and lake water level, water (spring) flow, water temperature

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