中国活断层研究专辑　　国家地震局滇西地震预报实验场研究成果

滇西北地区活动断裂

国家地震局地质研究所　　云南省地震局

地震出版社

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内 容 提 要

本书是国家地震局滇西地震预报实验场地震地质工作的主要研究成果，着重反映科研工作中取得的新资料、新认识。全书从深部到浅部，从老到新简要介绍研究区地质构造形成和演化的基本轮廓；在孢粉、^{14}C、热释光和地层资料基础上，重新建立场区新第三纪以后的地层年代表；根据电磁测深及地热资料提出场区存在上地幔上隆现象；从遥感信息、地貌、断层岩、地球化学、形变等方面，研究第四纪断层活动性质、现代构造应力场、构造块体运动、地壳运动学和可能的动力学模式和地震的地质成因。探讨了几个地震构造区晚更新世晚期以来地震发生的重复时间间隔，综合研究了潜在震源区划分和50年内的地震危险性。

滇西北地区活动断裂

国家地震局地质研究所

云南省地震局

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序　言

滇西北地区是我国新构造运动强烈、破坏性地震频繁的地区，与活动构造有关的各种地质灾害时有发生，严重地威胁着人们的生命和财产。为了监测和预报地震，国家地震局于1980年在该区建立了地震预报实验场。地震地质工作是中长期地震预报中一项重要的基础性研究。国家地震局地质研究所和云南省地震局的科研人员，组织力量投入了这一学科领域的研究。自1982年至1988年，经过七年的艰苦努力和细致工作，在大地构造、深部构造电性特征、地热、遥感信息、活断层、断层年代、断层物质、构造应力场、地壳运动、现代地壳形变、地震构造、古地震、地震活动性、地震重复率、潜在震源区和地震危险性方面取得了一批有科学价值的新资料，提出了许多新认识，使这一学科领域的研究取得了长足的进展，因而有条件撰写滇西地震预报实验场第一部学术性较强、应用性较广的专著《滇西北地区活动断裂》。与本区其它同类学科相比，本书的特色在于如下几个方面：第一，通过大比例尺活断层填图，新发现了大量晚第四纪以来的活断层、地震断层、古地震事件，这些发现深化了地震地质基础理论的研究；第二，对滇西北活动构造的几何学、运动学研究提出了许多新看法，诸如"X剪切区"、"裂陷伸展区"、"拉分区"、"尾端拉张区"等，这些看法有助于地震发生的地质原因解释；第三，活断层运动的定量半定量研究，获得了一批断层位移速率和地震位错量的数据；第四，通过断层陡坎、断错水系测量、地震楔等方面研究，查清了历史强震的位移分布和晚更新世以来的古地震事件，以此估算地震发生的真实重发间隔或平均重发间隔。这方面的工作在我国是80年代初开始的，本区的研究受中美合作研究红河断裂工作的促进，走在了前面，使地震地质研究纳入地震预报的轨道；第五，形成多学科探索的一条新路子。除常规的地震地质、新构造、活断层、年代学方面的研究外，还进行了地球化学、电测深、地热、地震、大地测量、构造模拟、断层物质显微构造、航卫片分析等学科的综合研究。无疑，这有助于对活动构造与地震认识的深入发展。

全书共十三章，其主线是：晚第四纪活断层运动—地震构造定性定量标志—地震重发间隔—潜在震源和近期地震危险性研究，围绕这条主线提供了许多新资料及由此而生的新认识。在前人工作基础上，获得若干方面的新进展，具有重要的科学价值。

《滇西北地区活动断裂》的出版恰逢联合国发动"国际减轻自然灾害十年"（IDNDR）计划的实施。无疑，它的意义必将超越滇西北和我国的界限，而起更大的作用。为此，我衷心地祝贺。

马杏垣

1989.10.9

PREFACE

Northwest Yunnan is a region which experiences intense neotectonic movement, frequent destructive earthquakes, and other geologic hazards related with active structures, and hence serious loss of lifes and properties. For the purpose of monitoring and predicting earthquakes, an earthquake prediction experimental field was established by the State Seismological Bureau(SSB) in the region in 1980. Seismogeological investigation is one of the important basic researches for long-term earthquake prediction. The researchers from Institute of Geology, SSB, and Seismological Bureau of Yunnan Province have made much effort in this discipline. Tremendous and detailed works, such as geotectonic, seismo-tectonic and paleoseismological investigations, electrical soundings, geothermal measurements, remote sensing, investigation of active faults and their material composition and ages, measurements of tectonic stress field, crustal movement and recent crustal deformation, and research on seismic activity, interval of earthquake recurrence, potential source zones and seismic risk estimation, were conducted during the period of 1982—1988, and a large amount of valuable data were obtained. It provides several aspects for understanding of the region studied, makes a great progress in this discipline, and hence provides a sound basis for preparing the first plentiful scientific and widely applied monograph *Active Faults in Northwest Yunnan Region* which is distinct from other previous similar scientific works covered this region in the following aspects: 1) The large-scale mapping of active faults permits to find a large amount of faults activated since the Late Quaternary, seismogenic faults and paleoseismic events, and deeply formulate the basic seismogeological theories. 2) Many concepts were suggested on the geometric and kinetic behaviours of the active structures in the region, such as X-shear zone, taphrogenic extension zone, pull-apart zone and tip tension zone were defined. It helps to decipher the geologic causes for earthquake generation. 3) The qualitative and semi-quantitative studies of the kinetic behaviours of the faults provide numerous data on the rates of fault displacement and dislocation by earthquakes. 4) Measurements of the fault scarps and disturbed streams and earthquake-generated wedges make it possible to clarify the distribution of displacements by large historic earthquakes and paleoseismic events since the Late Pleistocene, and hence to estimate their recurrence interval or mean recurrence interval. These works have begun early in 1980s, strengthened by the China-U. S. A. cooperative investigations in the region, and then further advanced by our researchers, so that the seismogeological research has made a great step toward the earthquake prediction. 5) A new multidisciplinary approach was formed. In addition to ordinary seismogeologic and neotectonic investigations and geochronologic study on the active faults,

a comprehensive research was formed in connection with geochemical, geothermal, seismological and geodesic surveys, electrical sounding, tectonophysical modelling, microfabric analysis of fault materials, and interpretation of aerophotos and satellite images. These works undoubtedly help to make a great advance in deep understanding of the active structures and earthquake generation.

The Monograph consists of thirteen chapters with a main guideline to research on "movement along the active faults since the Late Quaternary—qualitative and quantitative indicators for seismogenic structures—interval of earthquake recurrence—potential source regions and recent seismic risk". The guideline to the research provides numerous new data and hence a new knowledge on the region. Thus, several new advances were taken on the basis of previous and present investigations and are of important scientific value.

The Monograph *Active Faults in the Northwest Yunnan Region* is published during the implementation of International Decade for Natural Disaster Reduction (DNDR), launched by the United Nations. Its implication will be undoubtedly beyond the limits of the studied region and our country, and its role will be increased. For this I extend cor dial greetings.

Ma Xingyuan

October 10, 1989

前　言*

位于云南西北地区的滇西地震预报实验场是国家地震局为进行地震监测、探索地震预报开辟的科研基地，是多学科、多方法综合研究的野外实验室。以中长期地震预报为目标，为其它学科研究提供背景资料的地震地质工作是其中一项重要的基础性研究。基于各学科对"地质先行"的需要，国家地震局地质研究所和云南省地震局的有关科研人员，及时地组织力量投入这一学科领域的研究。经过长期艰苦努力，在许多方面获得了新的进展，为撰写实验场区第一部学术性较强、应用性较广的专著创造了条件。

滇西地震预报实验场，位于北纬25°—27°，东经99.5°—101°，即北起丽江，南至南涧，西起云龙，东至永胜，总计3万平方公里的面积。场区外围是北纬24.5°—28.0°，东经98.5°—101.5°，即北起中甸，南至云县，西起腾冲，东至楚雄，外围地区总面积约9万平方公里。本书涉及内容，有的限于场区范围，有的涉及外围地区。实验场区在地质上是三大构造单元的交汇区，被金沙江断裂、红河断裂和小金河-丽江断裂分开。东部为扬子准地台，北部是甘孜褶皱系，西和西南部是三江褶皱系。发育历史不同的三大块体在本区的交汇，使其形成结构多样、演化各异、活动强烈、地震频繁的复杂构造区。在地块总体抬升和上地幔隆起基础上，本区中部地壳拉开和伸展，形成相对下沉的裂陷区。裂陷区相对于周围地区低500—1000米。裂陷区周围是高山。北部为玉龙山、老君山，西部为苍山，南部为无量山、哀牢山，东部为光茅山、五顶山。高山与裂陷区之间、裂陷区内次级盆地与山岭之间分布着许多活动断裂。北西、北北东(或北东)向两组断裂支配着裂陷区的发展，形态上构成边长不对称的菱形断块，即滇西北菱形断块。地貌上著名的横断山构成本区的主体山系。地势西北高东南低。源于青藏高原的一系列平行水系，由西北向东南倾泻而下，使地形切割成相间排列的高山和深谷。由西向东有：高黎贡山、怒江、碧罗雪山、澜沧江、云岭-苍山-哀牢山、金沙江-元江、沙鲁里山-云贵高原。高山与深谷的海拔高差悬殊，最高的玉龙雪山达5500米，最低的河谷1500米，其高差达4000米左右。一般地势高度为海拔2000—2500米。

以大理白族自治州为中心的滇西地震预报实验场，山青水秀，气候宜人。自古以来各族人民在这块土地上耕耘，农业发达，人口密集，是云南历代的政治、经济与文化的中心。大理是唐代南昭国和宋代大理国的首府所在，劳动人民创造的灿烂文化至今还历历在目。大理三塔寺、剑川石钟山石窟、宾川鸡足山古寺、丽江明代壁画等是这些古迹中的佼佼者，它们以自己的丰碑谱写着大自然的变迁和社会的更叠。大理地区的"风花雪月"("下关风，上关花，苍山雪，洱海月")，勾画出一幅引人入胜的画景。加上能歌善舞的各族人民，使这个富有诗情画意的地方更加具有魅力，成了我国重要的旅游胜地。然而，与活动构造有关的各种地质灾害，诸如地震、山崩、滑波、洪水等时有发生，威胁着人们的生命和财产。其中，地震引起的灾害最大。根据历史记载，自公元886年以来，场区及外围地区共发生$M\geqslant4$级地震201次。其中6—6.9级地震20次，7级以上地震3次。最大的是1511年永胜7.5级地震。史书记载，震时

* 虢顺民、李祥根执笔。

“死者数千，伤者倍之”，“民居圮者1500余”。再者，1925年大理7级地震，造成“受灾4000余户，死3600余人，伤者倍之”的损失(顾功叙，1983)。解放后，7级以上强震虽未发生，但中、小地震却不断出现。如1951年剑川$6^{1}/_{4}$级地震，造成倒塌房屋27242间，死伤1208人的损失(李善邦，1960)。全区5—6级左右的地震，其时间间隔只有几年，十几年或几十年。于是一系列重要问题提出来了，强震发生的地质条件是什么？如何确定地震发生的重复间隔？潜在震源区在何处？这些是该区人民和生产建设所急待解决的问题。对这些问题的回答，有赖于对活动构造、地震构造、现代地壳形变、地震活动性等的深入研究。尽管这些问题相当复杂，不能靠几年的工作就获得圆满解决，但努力揭示场区活动断层的现今活动规律，查明地震发生的原因，无疑为更好地回答这些问题打下坚实的科学基础。

滇西北地区在我国大陆岩石圈动力学和运动学研究中占有重要的地位，它正好位于受挤压而强烈隆起的地槽褶皱带与稳定的扬子准地台之间。其最新构造的形成，源于板块作用下青藏块体隆起并向东南方向的滑移，以及滑移前方受扬子准地台的反作用力和来自西部印度板块直接推挤力的联合作用。因此，它是研究几大板块和断块运动的一个极好的构造窗口。也就是说，滇西实验场活动构造的研究对讨论中国大陆岩石圈动力学，特别是印度板块和欧亚板块之间的碰撞、青藏高原的抬升及向四周的流散具有重要的科学意义。

对滇西地区的地质地貌研究，早在解放前已经开始。李四光(1939)在《中国地质学》一书中将滇西归入扭动构造系，同时指出纬向构造和经向构造的存在。黄汲清(1945)在《中国主要构造单位》一书中把滇西划归“特提斯式燕山褶皱带”。瑞士地质学家P.Misch(1945)在研究云南地质历史的基础上，将大理地区列入云南“中部隆起”和“西部准地槽”的交接处。1959年张文佑把大理以西地区划归为“横断山断块”，其东为“康滇台向斜”，其北是“南昆仑槽向斜”。三者的界线大约为金沙江-红河断裂和箐河-程海断裂。后来，李四光(1965)进一步提出本区属于中国西部的“歹字型构造”，其中“点苍山、哀牢山属于这一构造的范畴”。黄汲清(1960)具体地指出“大理地区属于西藏滇西准地台、甘孜松潘准地槽、扬子准地台的交接处”。按照断块的观点，张步春等(1974)强调了北西向红河断裂、南北向程海断裂对本区构造的控制作用。马杏垣等(1961)则指出“滇西属地槽性质”，大理地区为“几个地槽的交接地带”。无疑，这些论点对滇西地区的地质工作具有重要的指导意义。

西南地区最早的地震地质工作开始于1956年。当时，李善邦、果尔什柯夫、徐煜坚等首次在野外开展研究，为地震烈度区划收集了新构造运动方面的资料。较深入的工作开始于1965年，中国科学院昆明地球物理研究所在川西和滇西地区进行的地震区划，对8万平方公里的地区开展了地震地质考察，完成了新构造图、地震构造图和地震区划图的编制。同时，地质部西南地震地质大队也在该区开展活动构造、地震构造考察，初次对红河断裂分段性作了划分，对大理和永胜地震区地震构造作了研究。赵国光(1965)对大理-丽江地区的新生代地层作了初步划分。这些工作为后期研究创造了良好条件。1971年开始的以西昌-渡口为中心的西南地震烈度区划工作，由国家地震局所属七个单位组成的西南烈度队承担，经过三年的地震地质考察和两年的综合研究，编制了该区烈度区划等系列图件和说明书，并出版了专著和论文集(1977、1978)，其中，讨论了大理、剑川、永胜地震区的发震构造。另外，有的文章从地质和地震资料出发，讨论了西南地区的构造应力场(徐杰，1977；阚荣举，1977)。这些工作和成果为当时全国的烈度区划工作提供了典型经验，对西南地区地震构造类型的划分和确认“川滇菱形块体”的存在及其向东南移动等方面提出了许多新见解。这是本区基础地质和地震地质研

究的起步和发展时期。

本区地震地质工作的新阶段开始于滇西地震预报实验场建立以后。1980年6月国家地震局为了我国地震预报研究工作发展的需要，并结合中美两国地震科技合作任务，确定在滇西地区建立地震预报实验场。地震地质工作走在各项研究的前头。从1982年开始，国家地震局所属的地质研究所、云南省地震局的地质人员携手合作，首先开进了滇西实验场。同时，地壳应力所、地震研究所、地球物理研究所、中国地质大学，也从不同角度承担了某些研究任务。在国家地震局科技司、地震科学联合基金会和滇西实验场的赞助下，地质研究所和云南省地震局承担了多种学科项目的综合研究。经过七年的艰苦努力和细致工作，在深部电性特征、地热、遥感信息、活断层、断层年代、断层物质、构造应力场、地壳运动学、现代地壳形变、地震构造、古地震、地震活动性、地震重复率和潜在震源区划分以及地震危险性研究方面取得了许多新资料，这些是撰写本书的基础。

归纳起来，我们的工作在以下几个方面取得了新的进展，或者说具有自己的特色。第一，通过大比例尺活断层填图，新发现了大量晚第四纪以来的活断层、地震断层、古地震事件，致使本区的活动构造研究出现了新的高潮。这一新局面的出现，促进了丰富的地质资料的积累，深化了地震地质基础理论研究。第二，构造上由静态进入到动态研究，即由几何学推进到运动学上的研究，对滇西北地区的构造提出了许多新的看法，诸如"×剪切区"、"裂陷区"、"拉分区"、"尾端拉张区"等。这些看法有助于地震发生的地质原因解释。第三，断层运动定量半定量化研究，包括晚第四纪以来的断层位移幅度、速率和地震断错位移量等。本区既有以走滑为主的断裂，又有以倾滑为主的断裂。这样的得天独厚的条件，为我们获得一批可贵的断层运动数据提供了机会。第四，通过对断层陡坎、断错水系、探槽揭露的地震楔等的研究，揭示历史强震的位移分布和晚更新世晚期以来的古地震事件，估算活断层关键段落的强震实际重复发生时间间隔或平均重发间隔。虽然这方面的工作在理论和方法上还有待发展和开拓，但它使地震地质工作由定性走向定量并纳入地震预报轨道迈出了可喜的一步。第五，形成多学科多途径的综合探索路子。除了常规的地表地质、新构造、活断层、年代学方面的研究外，还进行了地球化学、大地电磁测深、地热、地震、大地测量、构造模拟、断层物质显微构造、航卫片线性构造分析等研究。无疑，这些资料的综合研究，大大地促进了对活动构造与地震认识的深入发展。

国内外早期和同时期大力开展的活断层、地震断层、地震重复间隔研究中许多思路和方法也给了我们许多有益的启示(丁国瑜，1982；时振梁等，1973；邓起东，1984；汪一鹏，1986；马宗晋等，1980，1982；叶洪等，1980；张裕明，1986；方仲景等，1987；汪良谋，1982；马瑾，1987；李坪等，1975；艾伦等，1984；Wallace，1970，1977；Sieh，1978；Bucknam，1979；Hanks，1984；Zhang Buchun et al.，1986；Tapponnier et al.，1981)。

本书是7年来地震地质考察和各项研究工作的主要成果。撰写全书的一条主线是：晚第四纪活动断层的运动-地震重复发生的时间间隔-地震构造定性定量标志－潜在震源和近期地震危险性的研究。在这条主线中，着重反映我们得到的新材料及由此而生的新认识。第一章至第三章从深部到浅部、从老到新、从地层到构造地貌简要介绍地质构造形成和演化的基本轮廓。在孢粉、^{14}C、热释光和地层资料基础上，重新建立场区新第三纪以后的地层年代表。根据电磁测深和地热资料，提出场区存在上地幔上隆现象，它与上地壳的拉张、裂陷呈对应关系。第四章至第六章分别从野外地质地貌、断层岩、水文地球化学等方面研究第四纪的断

层活动性质和状态。各章都附有丰富的实际资料，为以后各章的撰写创造了必要的条件。第七章利用水准网、三角网和断层位移的多年复测资料，研究该区现今地壳垂直、水平位移特征和断层运动状态。第八、第九两章结合地质、地球物理、地形变、地震模拟等方面的工作成果，讨论了滇西地区现代构造应力场、构造块体运动、地壳运动学和可能的动力学模式。第十章研究了本区地震"时"、"空"、"强"变化的规律性，汇集了研究区及外围地区4级以上的历史和仪器记录的地震资料，特别是1925年大理地震时留下的一组震害照片(云南大理等属震灾筹赈事务所，1925)。这是一份十分珍贵的资料，它再现了当时的震灾实况。第十一章重点对几个地震区的构造作了剖析，在此基础上讨论地震发生的构造模式和发生的地质原因。第十二章探讨了几个地震构造区晚更新世晚期以来地震发生的重复时间间隔。对资料较丰富的永胜、大理地区讨论了强震发生的实际重复间隔，而在资料较少的剑川、洱源、宾川等地区讨论了地震发生的平均重复间隔。第十三章综合各章提出的与地震发生有关的各种参数，全面讨论了潜在震源区划分和未来的地震危险性。

在7年野外考察和研究的工作当中，50余名地质、地球物理、地球化学、地壳形变、地震等方面的科研人员辗转于横断山脉的山山水水，出没于苍山脚下、洱海之滨，以他们的辛勤劳动取得了一批扎实可贵的资料。地震地质人员为了取得系统、定量化的基础资料，普遍采用了活断层、地震断层的大比例尺填图和追踪、实测地质剖面图、断层微地貌资料统计和分析、大比例尺地形图和地形剖面图详测、槽探等方法进行野外研究。国家地震局地质研究所先后参加过地震地质工作的有虢顺民、李祥根、向宏发、冉勇康、吴大宁、尤惠川、王景钵、张晚霞、李如成、李柏栋；参加显微构造和断层物质工作的有林传勇、何永年、冯锦江、史兰斌、胡碧如、张秉良；参加地质年代工作的有严富华、彭贵、计凤桔、叶永英、麦学舜、焦文强、李洪春；参加电磁测深工作的有孙洁、徐常芳、史书林、江钊、王继军、何明；参加地热工作的有吴乾蕃、祖金华、谢毅真、王都；参加水文地球化学工作的有上官志冠、张培仁等；参加断层氡气测量的有张晚霞、李如成；参加地质雷达工作的有贾三发等；参加模拟实验的有王春华、廖素琼、郝宇红、盛淑珍。云南省地震局参加地震地质工作的有韩源、张靖、张俊昌、何希虎、胡荣卿、陈铁牛、张国伟、杨继武、侯学英、张双林、王晋南、冯巨鼎；参加地震活动性分析的有周瑞琦、董必献、李世成；参加地壳形变测量和分析的有刘玉权、杨来宝、胡关林、黎炜、黄震民、杨世华、张兴华、彭兴宽、段利群、王桂芝、丁建民、丁平、江在森、宋金铃、刘训云等。

国家地震局地质研究所的研究生吴大宁、邢全友、韩宝福、韩竹君、王晋南、林元武等以新的思路在本区开展了考察研究，取得的成果对本书撰写有较好的参考价值。

本书是全体参加工作人员的劳动结晶，也是在7年工作中各方支援的结果。趁此出书之际，向曾经给于大力支持和热情赞助的国家地震局科技监测司、地震科学联合基金会、滇西地震预报实验场以及地质研究所、云南省地震局和工作区各级地震部门深致谢忱。国家地震局科技监测司的李裕彻、朱世龙，地震科学联合基金会的吴宁远，地质研究所的刘若新、马瑾、邓起东，云南省地震局和滇西地震预报实验场的晏凤桐、王凤岐同志对本课题的指导和关心，都是特别值得我们感谢的。

全书由虢顺民、韩源、李祥根承担统稿和定稿。图件由郭京平清绘。

INTRODUCTION

West Yunnan Earthquake Prediction Experimental Field, located in Northwest Yunnan Region, is a scientific basis for earthquake monitoring and predicting, established by the State Seismological Bureau (SSB), and is also a field laboratory for comprehensive, multi-disciplinary research approach to medium-and long-term earthquake prediction. Seismogeological investigation, which is one of the important basic researches, was carried out by the scientists of Institute of Geology, SSB, and Seismological Bureau of Yunnan Province on the experimental field, and provides its background data for other disciplines in further research, which are also reflected in this monograph.

The West Yunnan Earthquake Prediction Experimental Field is located at the geographical coordinates of 25—27°N and 99°.5—101°E, and covers an area of 30,000 km² from Lijiang on the north to Nanjian on the south, and from Yunlong on the east to Yongshan on the west. Its outer region lies in an area of about 90,000 km² at 24°.5—28°.0 N and 98°.5—101°.5E from Zhongdian on-north to Yunxian on-south and from Tengchong on-west to Cuxiong on-east. The region is a geological conjunction zone of three tectonic units separated by Jinshajiang, Honghe and Xiaojinhe-Lijiang faults, and bounded by Yangtze Platform on-east, Garze Fold System on-north, and Shangjiang Fold System on-west and southwest. These three blocks are different in history of their development, and caused the region to form a complex tectonic zone with a variety of structures exhibiting their different evolution and high seismicity. The region has been subjected to extension and pull-apart which resulted in formation of a relatively depressed taphrogenic zone on a background of overall block uplifting and the upper mantle upwelling. The elevation of the taphrogenic zone is 500—1 000m lower than that of its surrounding mountains, such as Wulongshan, Laojunshan Mts on the north, Canshan Mt on the west, Wulianshan and Ailaoshan Mts on the south, and Guangmaoshan and Wudingshan Mts on the east. Many active faults are distributed between the taphrogenic zone and the high mountains and between the second-order basins and ridges within the taphrogenic zone. The NW- and NNE-(or NE-) trending fault systems have controlled the development of the region to form an asymmetric rhombic block with different edges, the Northwest Yunnan rhombic block. Geomorphically the Ailaoshan Mts are a major mountain system in the region. The relief is high on the northwest and low on the southeast, and is cut deeply into valleys down to 1500 m in maximum and mountains up to 5500 m in maximum by a series of the streams originated on Qinghai-Xizang Plateau. The altitude of the studied region is 2000—2500 m in general.

The experimental field is centered at Dali Baizhu Autonomous Prefecture, which

was a political, economic and cultural centre of Yunnan Province in history, and now is an important scenic spot in our country for tamples, grottoes, cliff drawings,frescoes,and fascinating natural landscape. But various geologic hazards related with active structures, such as earthquakes, landslides, rockfalls and floods frequently occurred. Since 886 AD, as shown in historic records, the experimental field and its surroundings have experienced 201 earthquakes of $M \geqslant 4$. Among them 20 events were of $M=6—6.9$, and three events of $M=7$ or more. The largest one is $M=7.5$ Yongsheng earthquake in 1511, which killed 1500 persons, and $M \geqslant 7$ Dali earthquake in 1925, which killed 3600 persons (Gu Gongxu, 1983). Time interval of $M=5—6$ earthquakes in the studied region is estimated to be from ten years to several decades. Thus one of the important problems is to study the geologic conditions for earthquake generation. The geological investigation of active faults, seismogenic structures, recent crustal deformation and seismicity in the region enables us to reveal the regularities of recent movement along the active faults and understand the causes and conditions for earthquake occurrence.

Northwest Yunnan region lies between geosynclinal fold belt uplifted under the compression and stable Yangtze-Huaihe Platform. Neotectonic movement has taken place by the uplifting and southeastward slipping of Qinghai-Xizang Plateau under the plate motion and the reaction of Yangtze Paraplatform on the front of the slip and immediate push and compression of Indian Plate. Therefore, it is a tectonic window for study of motions of some plates or blocks, i. e. study of the experimental field is of scientific significance for revealing geodynamics of continental lithosphere in China, especially collision between Indian and Eurasian plates, uplifting of Qinghai-Xizang Plateau and dispersion of surroundings.

Seismogeological study of Southwest China started early in 1950s, when Li Shanbang, Gorshkov, Xui Yujiang and other scientists carried out field investigations and collected data and informations on neotectonic movement for identifying seismic intensity. Then from 1965 a more extensive investigation was carried out by Kunming Institute of Geophysics, Academia Sinica, resulted in a seismological regionalization of the West Sichuan and West Yunnan regions and compilation of neotectonic map, seismotectonic map and seismic zoning map of 80,000 km^2. At the same time, Southwest China Seismogeological Team of the Ministry of Geology has developed its investigation on active structures and seismotectonics, resulted in segmentation of the Honghe fault zone, and seismotectonic investigation of Dali and Yongsheng seismic areas. These works provided a basis for later deep research. Since 1971, Southwest China Seismic Intensity Research Team organized from seven geological organizations of SSB carried out comprehensive investigation centered at Xichang-Dukou area for the purpose of seismic intensity zoning of Southwest China. As a result of the three-year seismogeological and two-year comprehensive investigation, a series of maps, collected papers and a monograph will be published.

Since the establishment of the Earthquake Prediction Experimental Field a new stage of seismogeological research had started in connection with China-U. S. A. cooperative seismological project in 1980, and extensive and detailed investigations have been developed since 1982 by scientists of Institute of Geology, SSB, and Seismological Bureau of Yunnan Province together with researchers of Institute of Crustal Dynamics, SSB, Institute of Seismology, SSB, Institute of Geophysics, SSB, and China Geological University by a comprehensive and multi-disciplinary approach for seven years. They obtained many new data and information on electrical properties of deep crust, geothermal regime, active faults and their materials and ages, tectonic stress, crustal dynamics, recent crustal deformatiom, seismotectonics, paleoseismic events, seismicity, time interval of earthquake recurrence, potential seismic source zones and seismic risk, which are the basic data for preparation of the monograph.

Summarizing the obtained data and information, we can make several advances in the following aspects:

1) Large-scale mapping of active faults in the studied region permits us to find numerous new faults activated since the Late Quaternary, seismogenic faults and paleoseismic events. It provides a new basis for deep research of the active structures, enriches the accumulated geological data, and leads to formulate the basic seismogeological theories.

2) After the investigations, many new concepts are suggested on the tectonics of the Northwest Yunnan region on the basis of analysis from previous static to present dynamic viewpoints, i. e. from the geometric to the kinetic studies. For instance, the concepts on X-shear zone, taphrogenic zone, pull-apart zone and tip tension zone were suggested. These concepts help us to geologically interpret the conditions for earthquake generation.

3) Semi-quantitative and quantitative studies of the fault movements, including the amplitudes, rates and amounts of displacements, and offsets and dislocations along the faults in the studied region, where either strike-slip faults or dip-slip faults are dominant. It permits us to accumulate many valuable data on fault movement.

4) Measurements and researches on fault scarps, disturbed river systems and streams and earthquake-generated wedges in excavated trenches make us possible to reveal the distribution of dislocations and displacements by historic earthquakes and understand paleoseismic evems since the late Pleistocene, and estimate real time interval of earthquake recurrence or mean recurrence interval on the key segments of the active faults. It makes the seismogeological research to step into a quantitative approach and contribute to earthquake prediction.

5) A comprehensive, multidisciplinary approach to seismogeology is formed. In addition to ordinary surface geology, neotectonics, investigation of active faults and geochronology it consists of geochemistry, magnetotelluric sounding, geothermics, seismology,

geodesy, tectonic modelling and microfabric analysis of fault materials, and interpretation of aerophotos and satellite images so it greatly promotes the progress in understanding the active tectonics and seismicity.

This monograph reflects the main results of seismogeological and other disciplinary researches in the West Yunnan Earthquake Prediction Experimental Field. It is prepared along a guideline to desipher "the movement along the active faults since the Late Quaternary—time interval of earthquake recurrence—qualitative and quantitative seismotectonic indicators for earthquake occurrence—determination of potential seismic sources and near-future seismic risk zones", with an emphasis on reflection of new data and new ideas.

The monograph consists of thirteen chapters. The chapters I-III give an outline of basic framework of the formations and evolution of geologic structures from stratigraphic, tectonic and geomorphic data, and geologic bodies from surface to depth and from older to younger. A stratigraphic-geochronologic column for the experimental field is composited up from polynologic, ^{14}C dating, luminescent and stratigraphic data since the Tertiary. The upper mantle upwelling was found from the data of electromagnetic sounding. It is correlated to the extension of upper crust and the taphrogenic zone.Chapters IV-VI deal with the behaviours and patterns of fault movements since the Quaternary from data of remote sensing, field geologic and geomorphic investigations, analysis of fault rocks, and hydrogeochemical research. These real data provide a basis for further discussion in the later chapters. Chapter VII gives the relevelling data obtained on levelling network and triangulation for many years, and measurements of fault displacements, which reveal the characteristics of recent vertical and horizontal crustal displacement and pattern of fault movement. Chapters VIII-IX give a description and a discussion on the recent tectonic stress field, motion of tectonic blocks, kinetics of crustal movement and possible dynamic model from the results of geologic and geophysical data in connection with ground deformation measurements and seismological modelling. Chapter X describes the regularities of time-space variation in seismicity, gives data on historic earthquakes and instrumental records of earthquakes of $M=4$ or more in the studied region and its surroundings, and in particular demonstrates a group of preserved photos on seismic hazards by 1925 Dali earthquake. In chapter XI an emphasis is made on tectonic analysis of several seismic areas, and a discussion is made on tectonic modelling and geologic conditions for the earthquake occurrence. Chapter XII deals with time interval of earthquake recurrence since the Late Pleistocene in several tectonic zones, and gives a real time interval of earthquake reccurrence in Yongsheng and Dali areas from a plenty of data and estimates mean time interval of earthquake recurrence in Jianchuan, Eryuan and other areas from insufficient data. Chapter XIII, summarizing various seismic parameters listed in the previous chapters, discusses on the identified potential source zones and seismic risk areas for future 50 years.

During the seven years more than 50 geologists, geophysicists, geochemists, seismologists

and geodesists have taken part in the field investigation and research under an effective support by the Department of Science and Technology for Earthquake Monitoring, SSB, Joint Foundation of Seismological Science, Institute of Geology, SSB, Seismological Bureau of Yunnan Province, and Leadership of the West Yunnan Earthquake Prediction Experimental Field.

In the process of preparation of the monograph a writting group was set to prepare the individual chapters. The draft of the monograph was finalized and generalized by Guo Shuanmin, Han Yuan and Li Xianggen, and the inserted maps and illustrations were drawn by Guo Jingping of the Seismological Press.

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