中国岩石圈动力学地图集

LITHOSPHERIC DYNAMICS ATLAS OF CHINA

国家地震局
《中国岩石圈动力学地图集》编委会

Editorial Board for Lithospheric Dynamics Atlas of China, State Seismological Bureau

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前　言

八十年代国际地球科学的多学科研究规划“岩石圈动力学和演化：地球资源和减轻灾害的纲要”的中心任务，就是要阐明岩石圈的性质、动力学特征、成因和演化。它把研究大陆及其边缘作为重点，这不仅是因为大陆岩石圈保存着地质历史记录的95%，其重要性还在于地球的这一部分实际上提供给我们几乎全部矿产和能源资源以及人类赖以生存的空间。

我国是一个以大陆为主体的国家，有着得天独厚的地质构造条件，理应在地球科学的前沿课题研究中作出应有的贡献。鉴于此，又考虑到国家地震局系统广大地学科技工作者，近20年来在地震监测、地震地质、形变测量、深部探测和其它地球物理观测研究中，已经积累了大量实际资料，有必要加以综合整理和提高。所以在1982年初，国家地震局下达了编制《中国岩石圈动力学地图集》（以下简称《图集》）的任务，作为“六五”期间的重点科研项目；《图集》以研究大陆岩石圈结构及其演化、新构造变动、地震活动为重点内容，这在国内外地球科学发展中是一个创举。

《图集》由马杏垣任主编，丁国瑜、高文学、张海根、张步春、马宗晋任副主编。下设编图办公室，挂靠国家地震局地质研究所，由蔡文伯任编图办公室主任。《图集》编纂由《图集》编委会具体领导，由国家地震局地质所、地震所负责，参加编绘单位有国家地震局分析预报中心、地壳应力研究所、地震测量队、地球物理勘探大队、兰州地震研究所，以及大多数省（区）地震局（办）。此外还有武汉地质学院、地矿部航空物探总队等外协单位。局内外参加单位共31个，编制人员约200余位。

《图集》从广义上讲共包括两个组成部分。它们是：1.这本拥有68幅图件和简要文字说明的《中国岩石圈动力学地图集》，是《图集》的主体；2.一幅1：400万《中国及邻近海域岩石圈动力学图》的挂图及其说明书。

《图集》和“挂图”编稿完成后，国家地震局曾于1985年10月22日—26日和11月2日先后在武汉、北京两地召开评审会。参加会议的有来自37个单位100余名代表，并聘请了著名专家黄汲清、李春昱、顾功叙、孙殿卿、郭令智、曾世英、王仁、陈述彭等组成评审委员会，对以上成果进行了认真评审，提出了许多中肯的意见和建议，对提高《图集》和“挂图”的质量起了重要作用。

图稿还曾于1986年经国际岩石圈计划委员会主席Raymand A. Price，Karl Fuchs 和秘书长Edward A. Flinn，Henk J. Zwart 审阅并提出宝贵意见，并将《中国岩石圈动力学地图集》和1：400万“挂图”作为国际岩石圈计划的出版物，编号分别为0125和0126。

由于当前国内外尚无同类的图集可以借鉴，所以此次编图是一个不断实践和摸索的过程。首先必须明确岩石圈动力学的基本概念和编图的思路。

目前对岩石圈的理解至少有四种，本图集采用了地震波的岩石圈概念，即包括广泛分布的上地幔地震波低速层之上的岩石层，它包含有地壳和岩石圈上地幔。至于动力学，如果从学科角度出发它研究的是产生或改变物体运动的力。而地球动力学内涵更广泛，它的对象是地球内部的力和各种过程。本图集所指岩石圈动力学主要为岩石圈的运动和变形及其与深部过程的关系。

《图集》由6个图组68幅图件构成。从构造环境、介质、结构、应力、运动、变形、深部过程和力源的角度综合阐明我国岩石圈动力学过程。它以我国地质基础图组所提供的构造格架为基础，作为岩石圈动力学过程的舞台，进而是全国性和华北地区性的专题图组，包括地球物理、地球化学、新构造变动和地震活动性的图件。它们对新构造时期（340万年前）以来，特别是现今活动着的地质和地球物理过程给以综合概括；汇集了我国岩石圈现代运动和变形，以及现今进行着的各种过程的信息，并表示了将来会导致运动的因素，如岩石圈的横向非均匀性、密度不均衡以及应力状态等。

最后，又把这些单个要素从省（区）地震构造和大区岩石圈动力学特征角度加以综合概括，使整个图集构成一个逻辑性整体。《图集》为把岩石圈动力学过程外推到地质过去（特别是新生代）或未来，提供了一个区域性地质构造格架，并以此为寻找资源、保护环境和减轻灾害服务。

马杏垣

INTRODUCTION

The International Interdisciplinary Research Program on the Dynamics and Evolution of the Lithosphere — The Framework for Earth Resources and the Reduction of Hazards, was established by ICSU in response to a joint proposal from IUGG and IUGS, in an attempt to meet some of the new challenges of the 1980's. The main objective of the program is to elucidate the nature, dynamics, origin and evolution of the lithosphere, with special attention to the continents and their margins, because it is the continents that contain what remains of the first 95% of the earth's history. The evolutional history of the continental lithosphere is complex, and is much less well understood than even the imperfect evolutionary history that has been outlined for the oceanic lithosphere. Therefore one of the principal motives behind the lithosphere program is to fill this gap in our knowledge of that part of the Earth that has provided virtually all our mineral and energy resources, and the space in which we live.

China is situated in the southeastern part of the Eurasian Plate, which is in a unique geodynamic position, thus offering a good opportunity for study of dynamics of continental lithosphere. In the past 20 years a wealth of new data from all branches of earth sciences and from every provinces has been accumulated. Thus the time appeared right for an attempt at a comprehensive treatment of the new data and insight gained so far. This consideration promoted the State Seismological Bureau to establish a Lithospheric Dynamics Map Project in 1982 to produce a comprehensive set of 68 maps on the scale of 1:14 000 000 and a 1:4 000 000 scale Lithospheric Dynamics Map of China and Adjacent Seas.

The map project is directed by the Editorial Board, the chairman of which coordinates map production through Project Office in the Institute of Geology, State Seismological Bureau. More than 200 earth scientists from 7 different Institutes of State Seismological Bureau and the Provincial Seismological Bureaus and also from Wuhan Geological College, the Aerogeophysical Team of the Ministry of Geology and Mineral Resources have taken part in this work.

The Atlas portrays the lithospheric dynamics of China comprehensively through 6 series of maps, including geology, geophysics geochemistry, neotectonics, seismicity, provincial seismotectonics and regional lithospheric dynamic features. The geological map series serves as a background for the lithospheric dynamic processes, beacuse it is believed that the earlier tectonic evolution may furnish some guidelines for subsequent dynamic processes. The other map series assemble information on movement and deformation of the lithosphere and illustrate processes that occurred during the Neotectonic period (since 3.5 Ma ago) and that are taking place now. It also provides data on the nature of the lithosphere, crustal and upper mantle structure, geothermal data, density imbalance and state of stress that might cause future movements. Thus the Atlas provides a background for further research on contemporary lithospheric dynamics and serves as regional framework for extrapolating those active processes into the geological past and the future.

The assessment, prediction and mitigation of the geological hazards are of the principal areas of immediate applicability of the research results to be achieved under this program. The research will also contribute knowledge needed for protection of environment and for exploration of mineral and energy resources.

Ma Xingyuan

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中国岩石圈动力学地图集

图组说明

地质基础图组

地质基础图组是岩石圈动力学研究过程的基础和背景图件。它包括：1、中国地质图；2、中国前寒武纪构造格架图；3、中国大地构造图；4、中国中、新生代构造纲要图和5、中国卫星影象活动构造判读图等。其中地质图客观地勾画出我国地壳表层出露的岩系，反映了地壳构成上的非均匀性。大地构造图突出了古生代的构造过程，因此与前寒武纪构造格架图和中、新生代构造纲要图一起构成一个系列，通过构造—沉积—岩浆岩组合，不同时代的变形和各种构造单元反映出我国构造的总轮廓和构造演化。

目前大多数构造图仍然是以褶皱带作为基本单元，以褶皱带的固结时期划分阶段的。但自“新全球构造”问世以来，构造观有了很大变革，许多地质学家按板块构造的观点编制构造图。前寒武纪构造格架图和大地构造图的编者也作了一些新尝试，以大洋的“开”与“合”为主线，分析构造环境，鉴定构造要素，并按解析构造学的原则与方法，综合起来，得出各阶段的构造格架。

卫星影象判读图从客观的尺度观察我国大地的表层结构，作者利用各种标志尽力辨别出活动的构造，无疑这些都是岩石圈动力学的要素。

马杏垣

地球物理和地球化学图组

本图组主要由1°×1°布格重力异常，1°×1°自由空气重力异常，1°×1°均衡重力异常，1°×1°航磁异常，地壳厚度，新生代岩浆岩分布，地热特征和热震状态等8幅专题图件所组成。通过这一图组表明我国的重、磁、热等地球物理场的基本特征和新生代岩浆活动及其地球化学特征情况，以及它们所反映的我国岩石圈结构和地球动力学特征的某些侧面。

布格重力异常和自由空气重力异常图是根据国家测绘局编绘的1：100万中国布格重力异常和自由空气重力异常图以及中国科学院南海海洋研究所编绘的1：300万南海地区布格重力异常图，在1°×1°的方形面积上均匀取24个点，然后求其平均值的方法编制的；海域地区的自由空气重力异常是根据布格重力异常换算的。均衡重力异常是根据爱黎—海斯卡宁的模型计算的，绘图点原则上每1°×1°选取一个。航磁异常图是在1:100万全国航磁图的基础上，沿经度和纬度各1度范围内取平均值编制而成。此航磁异常图的等值线间隔基本上为50nT，在局部地区增加了25nT的辅助线。青藏高原的西部地区，由于尚未进行航磁测量，所以在图面上为空白区。由于重力、磁场图所示是在1°×1°范围内的平均结果，因此大量细节已被略去，仅保留了区域性的重力、磁场基本特征，即浅部的地质因素影响被消除，深部地质因素的影响更为突出。

地壳厚度图是根据1°×1°布格重力异常选用各向均匀的单层地壳模型，采用SinX/X方法计算出来的。在计算中选用唐山地区为起始点，地壳厚度为34公里，区场重力异常值为11毫伽。众所周知，利用重力资料，采用简单的地壳模型计算地壳厚度，尤其是在没有大量人工地震测探资料控制情况下，精确程度是很低的，特别是在构造复杂和重力均衡失调地区可能会得出错误的结果。根据目前已知的、人工地震测探资料所给出的地壳厚度数据，本图所反映的我国地壳厚度变化的总趋势还是正确的。

地热特征图是在国内各有关单位进行地热普查勘探、地质勘探和矿山开拓所获得的有关资料和成果的基础上编绘的。图中包括我国境内的温泉分布及温度等级和水化学类型的划分，部分地区的大地热流数值以及千米深温度及等温线等实际资料。通过这些素材，试图反映中国境内的地热基本状况。但由于在本图幅编制过程中，只能搜集到为数不多的大地热流数据，因此比较缺少能反映我国大地热流分布特征的素材。

热震状态图的编制是一个新的尝试。首先，通过一种统计方法，计算出每0.5°×0.5°的经纬方格面积内的热泉温阶指数加权和K（K值与统计面积范围内的温泉数目和温度高低成正相关），并按其大小划分为四个等级，再参照火山、地幔低速层分布和大地热流等数据，把中国领域划分为若干个地热活动带和活动区，做为地热单元。其次，利用中国1900—1976年间发生的$M \geqslant 6.0$级的地震所释放的能量和能量释放速率及其与区域地质构造单元的关系，把中国领域划分为若干个地震能量释放单元。然后，通过分析、对比地热单元和地震能量释放单元之间的关系，研究我国地震活动与地热活动之间的联系。

新生代岩浆岩分布图，主要是根据有关部门编制的地质图件、石油勘探成果和野外地质调查及新生代岩浆岩的同位素年代测定以及地球化学研究成果为基础编制而成。图中包括新生代岩浆岩分布、岩性、年代、活动方式和地球化学特征等有关内容。为了解新生代以来我国岩石圈的活动特性和深部物质活动情况提供素材。

本图组中的各专题图件所反映的科学内容，在各自的文字说明中均有简要描述，但应指出，这些专题图件之间反映

了某些明显的共同特征。例如，以东经102°—107°间的南北带为界，中国境内的重力、磁场特征截然地分为东西两大部分：东部区域重力、磁异常走向以北东—北北东为主，间夹一些近东西向异常，西部则以北西西向为主；东部均衡重力异常和自由空气重力异常均很微弱，而西部则十分强烈，但青藏高原基本处于均衡状态；地壳厚度在东部由海域地区向西逐渐加厚，在西部则由具有巨大地壳厚度的青藏高原向北逐渐变薄，南北带是地壳厚度突变带。在东部从大陆边缘向内陆方向温泉密度逐渐减小，温度逐渐降低；在西部则由青藏高原向北温泉密度逐渐减少，温度逐渐降低。新生代岩浆活动也主要以中国大陆东部边缘或近于边缘地区为主，青藏高原也有较多的新生代岩浆活动。上述特点可能反映了太平洋板块和印度板块对中国大陆作用的结果，南北带可能是中国大陆内部的一个巨大的构造分界。

刘国栋

新构造变动图组

晚始新世至渐新世间印度板块与欧亚板块发生碰撞（喜马拉雅运动第一幕）以后，上新世末至早更新世间的构造运动是对我国地壳最新变形和地貌发育影响最大的一幕构造运动。约340万年前发生的这一构造变动深刻地影响着我国的现代地壳应力场；致使现代地壳运动一直承袭着上新世末以来构造运动的基本状况。一般所谓的新构造期这就是指自此次构造运动迄今的这一构造发展阶段。

我国处于欧亚板块的东南隅，明显地受到了周围板块相互运动和作用的强烈影响，是全球各大陆板块内部新构造运动异常活跃的一个地区。地壳大幅度压缩和高高隆起的青藏高原、拉张开裂和深深沉陷的东部平原及盆地、一系列大幅度平移滑动的活动走滑断层以及穿插分布于强烈褶皱变形山带之间的刚性地块，这些各具特色的活动构造单元共同组成了一幅多彩的新构造变形和运动的复杂图象。

本图组主要由新构造、活动断裂及其现代运动、现代地壳垂直形变、新生代以来应力场的演化、现今应力场、震源断裂类型等方面的专题图件所组成。目的在于通过这一组图幅，从多方面来反映我国地壳演化最新构造阶段的应力应变有关的各类活动现象。新构造图表示了新构造单元的划分，新构造活动隆起区、沉陷区的分布以及断裂、火山、温泉、岩浆活动情况，着重反映我国在新构造期以来的地壳垂直运动和变形的总貌。现代地壳垂直形变图是在整理分析我国30多年来多期水准复测资料的基础上编制的，它反映了这一时段我国大陆现代地壳垂直变形的基本特征。活动断裂图除展示了全国各地不同类型活断层的展布情况外，还表示了一些主要活断层的现今运动情况。现今应力场图是根据原地应力测量、震源机制和形变资料编制的，它反映了我国现今不同深度应力的基本状况。地震力学是研究现代构造运动的动力学的一个重要领域，震源断裂类型图是这方面近年来所积累资料的综合分析图件，反映了我国构造地震在震源这一深度上地壳的现今应变的一些特点及其破裂的基本动力学特征。新构造期及现代地壳块体运动图则是在对断层活动、应力场等分析的基础上反映我国大陆内部动态的一个图件，是一个着重反映板块内部各地壳块体间相互运动及变形状况的综合性图件。

对地壳、岩石圈最新构造发展阶段，特别是对现代构造运动和当前正在进行的作用的了解是地球动力学研究中具有最重要意义的领域之一。在新构造变动这一图组中，对近年来积累的有关地壳最新的垂直与水平运动和变形、应力状况、断层活动、地壳块体的相互运动以及各类板内新构造活动现象的主要事实和资料尽量地在各幅主图中给予反映。一些关键的说明书与补充则放入附图中予以表明。各个图幅的资料与内容虽各有侧重，但它们相互补充，相互关联，可共同作为认识和分析我国现代地球动力学特征的一个基础。

丁国瑜

地震活动图组

构造地震，它的空间分布显示岩石圈活动的构造形态；它的时间分布反映地壳应变能量和应力状态的“微动态”；而它的序列类型和地表破裂特征则表现震源区岩石圈的细结构和动力过程。总之，具有物理的和历史的双重属性的一次次地震，就象岩石圈萤光屏上多种色彩的光点一样，展现着岩石圈现今动态的一组组片断。为展示这些片断，编制了历史的和现代的地震震中分布图、震源深度分布图、地震线图、地震震源机制图、地震破裂特征图和地震的时空变化图。

中国东部历史地震和现代地震的分布基本相似。各地震分区的地震活动程度明显不同，但地震均发生在地壳的中上部，而且均以北东—北北东和北西—北西西两组地震线交织的网络为基本图象，这是大陆区地震构造的基本特征。震源机制解表明，中国东部正受着近东西向区域压应力场的作用，长江口以北应力主轴偏北，以南应力主轴偏南。

中国西部的强震分布首先与岩石圈的结构类型和由地壳厚度陡变带所显示的岩石圈构造有关。从贝加尔湖的南端至中国横断山脉的中蒙经向中轴强震带、从贝加尔湖南端至帕米尔的北东向强震带和沿着喜马拉雅山的北西向弧形强震带，这是围绕青藏高原和内蒙古西部高原的三条巨大的地壳厚度变化带，总体结成一个三角形。这是世界上地壳厚度最大的

地区，也是大陆内8级地震最集中的地区，它们是中国西部强震区的基本根据。该区内部的细分区与强震带的展布，次级岩石圈结构的差异、地壳厚度陡变带以及大型边界断裂带有关。在上述格局的基础上，仍然显示以北东和北西西两组地震线为主的网络图象。不过从震源机制解和地震破裂的旋性可以看出，中国西部的区域应力场是以近南北向的挤压为主，从地震的强度和频度分布来看，区域动力作用是以来自喜马拉雅山带以南的挤压为主。

虽然中国东西两大区地震活动特征明显不同，但短时间内仍受统一应力场的作用。本世纪以来中国及其邻区的地震活动的时空变化表现出四次活动高潮，称为地震活跃幕，每幕十余年，其间有三次低潮，称地震平静幕，平均十年左右，目前正处在从1976年以来的第四次平静幕之中。而每幕的地震活动则以某一两个地震区或地震带方向为主，幕与幕之间有大尺度的空间转移和变换，这是几十年尺度地震预报的主题，也是岩石圈现今应力场微动态的真实表现。

马宗晋　高维明

地震构造图组

地震活动是现代构造运动最明显的表现形式，它们又是在一定地质构造背景下发生的。地震构造图应以图件的形式来表示地震活动性与构造地质、特别是与新构造运动的关系。所以它的编制不仅可提供地震活动的地震地质背景资料，同时也为地震烈度区划提供依据；另外还为探讨现今构造运动和岩石圈动力学的研究提供必要的基础材料。

本图组共有图件29幅。各省（区）以行政区为单位各自成幅，共计28幅。其中河北与北京、天津合为一幅，江苏与上海合为一幅；南海地区单独成图。省区地震构造图主要是客观地反映各省区构造地质与地震活动性之间的各种动态、静态的实际资料。为了反映全国地震构造总体特征，还编制了一幅全国性的地震构造图，它是在前者基础上，再次概括和综合，几经筛选，又加补充而编成。

以动力地球模式来探讨大陆岩石圈结构及其演化，研究孕震规律，必须深入加以剖析。为了能清楚地反映地震活动的地震地质条件，图件中将由结晶基底、沉积盖层和褶皱带（区）所组成的隆起区分别予以表明。在较古老结晶基底范围内，还进行前寒武纪基底等深线的编制，这将有助于对岩石圈结构特征的了解。盆地构造的形成和发展是反映岩石圈演化和动力学过程的灵敏“指示计”，所以将类型众多复杂、研究程度不一的盆地和拗陷使之系统化，按时代分别归纳为以下七种类型：中生代—新生代的、晚侏罗世开始的、早白垩世开始的、晚白垩世开始的、早第三纪开始的、晚第三纪开始的和第四纪的。在研究较为深入的盆地中，可以将反映盆地沉降速率的地层沉积厚度绘制成沉积等厚线，现已分别划分为中生代—新生代的、新生代的、第三纪的、晚第三纪—第四纪的和第四纪的沉积等厚线。它们将为岩石圈动力学的分析提供具体的依据，有助于对岩石圈上部结构的探索和了解。组成岩石圈结构各层次的岩浆活动，为了突出与地震构造密切有关的部分，图幅中表示新生代以来的岩浆岩类，特别对新生代的喷发岩类作了进一步的划分。

对大陆岩石圈结构的认识，除上述外，还得借助于地球物理勘探观测数据的计算和解释，图幅中编绘了反映不同层次的内容：航磁异常带、重力异常带，地壳等厚线，东部地区的热流值等。同时还利用地震活动的震源深度资料和震源机制解的分析，这些从某种角度、不同程度地阐述了岩石圈上部不同深度的受力情况、运动方式、应变状况和结构特征等。

新构造变动反映了岩石圈演化中最新构造阶段的运动特点，图幅内根据动态观测资料首先得从活动构造形迹着手加以剖析。结合地震地质调查、地球物理勘探的解释等划分出新第三纪以来的活动构造，特别是第四纪以来的活动构造，对断裂活动必须分辩其活动性质和方式，对褶皱构造还应区分拱曲，挠曲等构造现象。对具有形象直观、宏观特点显著的卫星影象遥感资料也要进行有效的判读，解释其活动的线性构造。至于通过地质调查计算、形变测量、地应力测量等测试资料所获得的运动速率尤为重要，它们对动力学过程的特点给予了定量或半定量的鉴定。地震断层和地震构造裂缝带的形成，新生代岩浆活动、特别是全新世喷发活动的出现，近期火山口和泥火山口的分布，以及＞25°C温泉的出露都可认为是新活动的标志，表现近期地壳的活动性。

作为《图集》三大主题之一的地震活动也是地震构造图内容的重要组成部分，它可以理解为岩石圈内现今应力场中动力学作用的结果。以仪器纪录的地震活动为准，将地震划分为1900年以前和以后两大阶段。由于各省（区）地震活动有着很大的差别，所以对强震活动地区和无震或少震地区的表示方法有所区别，对余震及震群活动也专门予以规定。震源深度分布表现为岩石圈不同层次的“微细”结构的特色，所以将浅源地震更详细分级为0－20、21－40、41－70公里三类。同样反映震源应力状态的震源机制解是岩石圈不同深度区域应力场作用方式的“窗口”，为了避免与其他图组图件的重复，在图幅内只作为解释发生地震的活动断层的性质，并且与图面的活动断裂相呼应。

本图组在《图集》中虽是由若干地质、地球物理、大地测量等单项学科内容横向综合编制成图，但仍是以反映实际材料为主。不仅有补充说明某些细节的附图、插图，而且还列有便于查对的主要活动断裂与盆地表，以供读者自行分析研究。此外，由于受各省(区)范围的限制，因此对某些规模较大、地跨数省的大型构造单元的讨论，则出现或叙述不全，或难免重复之弊。

地震构造图件中所列举的活动构造，能作详细研究者多限于揭露的地表部分，地球物理探测工作开展不多，目前很难全面展开研究。而地震活动皆多发生于地下20公里以内的部位，现在图面上所绘制的地震震中符号实是其投影位置。活动构造如延深到震源地带，未必一定符合现在图上所表示的情况，特别现经过深部构造的研究已经证明，有的活动断层深延后已改变原有活动方式和运动性质。何况现在深部已发现有大型推复、滑脱和铲式等构造形迹的报导。因此地

震构造图编制的深化必需大力加强深部构造的研究。现在岩石圈动力学研究的深入开展也正是推动地震构造深化发展的必由之路。

蔡文伯

岩石圈动力学特征图组

中国是受太平洋岛弧系和喜马拉雅—阿尔卑斯造山带这两条全球性现今动力边界的扶持，是全球一级岩石圈动力学特征区。它不断地显示着上述两大动力边界和中国大陆岩石圈自身的演化以及三者的相互作用。

中国的岩石圈结构和动力学特征可以综合地分为7个二级分区，它们是东部的东北区、华北区、东南区、台湾区和南海区，西部的西北区和西南区（青藏区）。

东北、华北、东南三区的地壳厚度都是西厚东薄，由45公里左右渐变为30—20公里。大兴安岭—太行山—武陵山是一条斜贯东部大陆的北东向重力梯级带，地壳厚度陡变带。三个分区上地壳构造走向都以北东向为主，它们所处的动力学环境总体上是统一连贯的，可能与西太平洋岛弧系的动力作用有关。但三个分区各自的岩石圈结构，上地壳的地质组成和演变时代，中新生代构造盆地的发育特点和时代，岩浆—火山活动的程度、成分和时代，活动断裂的活动速率，地壳形变的强度和特点，地震活动的强度与频度等，均显示三个分区的差别和彼此的相对独立。其中，华北地区岩石圈厚度最薄，约70—80公里，地壳结构最复杂，中地壳常表现为低速层或高低速夹层结构，莫霍面往往为过渡带形式。这些特点与华北地区的岩石圈在新生代时期的强烈伸展如岩浆大量侵入有关。台湾区范围很小，但它是西北与太平洋岛弧系中一个突出的弧结点区，大洋壳与大陆壳在这里碰撞，而且与东西区保持了密切的联系。南海区是中国唯一的兼有陆壳和洋壳的地区，并以其小区段的洋底扩张运动为重要特征。

中国西部的两个分区与内蒙古西部高原一起构成东西内陆很突出的地壳增厚区，厚度变化梯度值普遍高于中国东部。中国西部基本构造方向以近东西向为主，尤以重力梯度带和地壳厚度梯度带的延伸方向更为明显。但上地壳的北西或北西西向构造线也很突出，与中国东部的北东向构造线对照鲜明。西北区与西南区的主要区别，首先是地壳总体结构的差异，西南区是一个拼合断块体，又是南北向受压的联合隆起区，地壳剖面的总表现是上凸下凹；西北区是一个大型盆地与条状断块山联合的相对拗陷区，地壳剖面的总体表现是上凹下凸。其次，西北区广泛分布着前寒武纪结晶基底，古生代基底很少，新生代巨厚堆积大面积分布，地壳速度分层明确且相对简单；西南区则以广泛的古生代基底为主，高原面上只散布许多新生代浅盆堆积，地壳的速度分层复杂。

中国东部与西部之间为纵贯南北的重力分区带，西部的东西向山系至此均转为南北向，南段构成著名的横断山系。此带是著名的南北向中轴地震带。

综上所述，本图组的二级分区，既有各自的岩石圈结构和动力特征的独立性，又有横向的过渡、穿插和上下的交迭。在长时期的地质历史中，动力单元有过复杂变化，本图组的分区只是相对的，更强调了现今岩石圈动力特征的分区边界。

马宗晋　刘国栋　谢广林

LITHOSPHERIC DYNAMICS ATLAS OF CHINA
EXPLANATION TO MAPS

GEOLOGICAL MAP SERIES

The geological map series serves as the basis and background for studying the lithospheric dynamic processes. It consists of a series of five maps including those on the geology, geotectonics, Precambrian tectonic framework, Mesozoic-Cenozoic tectonics and structures interpreted from Landsat images of China.

The geological map is quite objective, which depicts rock groups of various ages and other main geological features. Therefore it contains the basic geological information that will form the background for the other thematic maps.

The three tectonic maps give a tectonic synopsis of the Precambrian, Paleozoic, Mesozoic and Cenozoic time. So far most tectonic maps use the fold belt as the basic unit and the geosynclinal theory as the basic philosophy. However, the advent of new global tectonics produced a revolution in the Earth sciences. Therefore the authors have tried to incorporate plate tectonic concepts in the tectonic maps. In the light of ocean 'opening' and 'closing', the tectonic evolution of different stages has been revealed by the analysis of the tectonic environment and the tectonic-depositional setting of the rock units involved, the identification of tectonic units and structural elements and the various ages of deformation that have affected them.

The interpretation of the Landsat images gives a general view of the surface structures in China, among which the active structures have been differentiated through various criteria.

Ma Xingyuan

GEOPHYSICAL AND GEOCHEMICAL MAP SERIES

The map series mainly consists of Bouguer gravity anomalies averaged in grid $1^{\circ}\times1^{\circ}$, free-air gravity anomalies averaged in grid $1^{\circ}\times1^{\circ}$, isostatic gravity anomalies averaged in grid $1^{\circ}\times1^{\circ}$, aeromagnetic anomalies ($\triangle$Ta) averaged in grid $1^{\circ}\times1^{\circ}$, crustal thickness by gravity inversion, distribution of Cenozoic magmatic rocks, geothermal features and geothermics and seismicity. The main purpose of compilation of this map series is to show the general characteristics of some geophysical fields in China, such as gravity, geomagnetic and geothermal fields, reflecting some features of the lithospheric structure and geodynamic processes in China.

Since the gravity and aeromagnetic maps resulted from averaging the gravity and magnetic fields in grids $1^{\circ}\times1^{\circ}$ respectively, a lot of details in both fields have been smoothed out, however, the general configurations of the fields still remain. The crustal thickness has been estimated from the mean Bouguer gravity anomalies in grids $1^{\circ}\times1^{\circ}$ by using the sin X/X formula, even though the method is simple, the results are basically true in reflecting general tendency of variation in crustal thickness in China. The hot springs are grouped in accordance with their temperatures and hydrochemical types, and heat flow values and isotherm at the depth of 1 000 m have been involved in the geothermal features map. Using this information we try to show some general state of the geothermal field in China.

By analysis and comparison of the geothermics and seismicity maps a relationship between the geothermal activities and the seismicities in China has been revealed. The locations, ages, lithological characteristics, patterns of magmatic activity and geochemical features of the Cenozoic magmatic rocks have been included in the map of Cenozoic magmatic rocks.

Some common features have been revealed in this map series. For example, from the features of gravity and geomagnatic fields the continental part of China can be divided into a specific western region and a specific eastern region. The boundary between them is a north-south geotectonic belt along an eastern longitude from 102°(South) to 107°(North). The regional trend of gravity and aeromagnetic fields is mainly in NE-NNE direction, but some regional anomalies in EW direction also can be seen in the eastern region. The regional trend, however, is mainly in WNW direction in the western region. The isostatic gravity anomalies and free-air gravity anomalies are very weak in the eastern region and are very strong in the western region, but are nearly isostatic on the Qinghai-Xizang Plateau. The crustal thickness is gradually increasing from the eastern sea area toward the western mountain area, meanwhile in the western region the crustal thickness is gradually decreasing from the Qinghai-Xizang Plateau with a maximum thickness northward to the northern border. The density of distribution and the temperature of hot springs are gradually reduced from the eastern continental margin toward the inland and are gradually reduced from Qinghai-Xizang Plateau toward northern border in the western region. The magmatic activities during the Cenozoic time mainly occurred in the eastern continental margin or in the adjacent area. In addition, many Cenozoic magmatic activities had also taken place on the Qinghai-Xizang Plateau. The above mentioned facts may reflect a result of combining effects of the Pacific Plate and Indian Plate on the China continent.

Liu Guodong

NEOTECTONIC MAP SERIES

China is situated in the southeastern part of the Eurasian plate, being apparently affected by the relative motion and action of the surrounding plates. China is thus one of the regions with abnormally high neotectonic activity within the continental plates of the Earth. The neotectonic map series reflects from various aspects data on neotectonic phenomena produced by stress and strain variations during the neotectonic period (since late Pliocene) of evolution of the crust in China. The Neotectonic Map shows the divisions of neotectonic units, neotectonic uplifts and depressions, volcanoes, hot springs, magmatic activity and so on, and emphatically reflects an overall picture of vertical movement and deformation of the crust in China since the neotectonic period. The Map of Rate of Recent Vertical Crustal Deformation is compiled on the basis of processing and analysis of data obtained by multiple repeated leveling performed in the past 30 years or more in China. It reflects the basic features of the recent vertical crustal deformation of China continent during that period. The Map of Major Active Faults illustrates the distribution of various types of active faults in all regions of China, and also indicates the recent state of motions along the major active faults. The Map of State of Recent Crustal Stress is prepared from the data on in-situ stress measurements, focal mechanism solutions and deformation, showing the basic state of stress at different depths in China. The seismomechanics is an important field for studying the dynamics of recent tectonic movements. The Map of Focal Dislocation and Seismogenic Stress Field is prepared from the results of comprehensive analysis of data on this aspect of China accumulated in last years, elaborating some features of strain and basic characteristics of fractures within the crust where the earthquake focuses are located. The neotectonic map series reflects as fully as possible the main facts and data on various intraplate neotectonic phenomena accumulated in recent years. Some main indications and supplements are shown in the attached figures. Since the maps and figures emphasize their specific data and contents, they may be supplemented and related each with other, and hence provide a basis for understanding and analyzing the recent geodynamic characteristics in China.

Ding Guoyu

SEISMICITY MAP SERIES

Spatial distribution of tectonic earthquakes portrays the patterns of active tectonics, and their temporal distribution reflects stress and energy of "microdynamic status" in the lithosphere.

Seismic sequences and surficial fracture features are expressions of microtextures of focal areas and the dynamic processes of the lithosphere. In a word, earthquakes, one by one, which provide both physical and historical information, display, section by section, the present-day dynamic status of the lithosphere, as shown on a screen with different colors. In order to trace these sections, this map series is compiled.

In eastern China, distribution of historical earthquakes is similar to that the instruments recorded, but seismological regionalization and degree of seismicity are remarkably different. Nevertheless, one thing is the same, all earthquakes are generated in the middle and upper crust, and along the network woven with NE-NNE and NW-WNW seismogenic lineaments. Focal mechanism solutions show that the principal compressive stress axis is in nearly EW direction in eastern China, in ENE direction north of the Yangtze River, and in ESE direction south of it.

Strong earthquakes in western China are related to the lithospheric structures, and to the sharp change in crustal thickness. Three strong earthquake belts, a longitudinal mid-axial belt which goes from the southern end of the Baikal through China and Mongolia to the Hengduan Range of China, a NE-trending strong seismic belt from the southern edge of the Baikal Lake to the northern Pamir, and an NW-trending arcuate seismic belt along the Himalayas, constitute a triangle crust-thickest region. These three belts correspond to three large thickness-changing belts in the Qinghai-Xizang Plateau and western Nei-MongolPlateau. Its thickest crust is one of the conditions for its active seismicity. Its microzonation are related to seimic distribution, difference in subordinate structures of the lithosphere, sharp change in crust thickness, and the large-scale boundary faults. On such a setting, the seismogenic lineaments also run NW and NE, forming a net-like pattern. However, focal mechanism solutions and seismic slipping on faults show that the principal compressive stress axis runs NS, and that the regional dynamics results from the compression south of the Himalayan Range as indicated by intensity and frequency of earthquakes.

Although the seismicity is greatly different between eastern and western China, It is subject to unified stress field in a short time period. Four high seismicity periods called seismoactive episodes during this century have been recognized in China and its adjacent areas. Each episode lasts about ten years or more. Between active episodes are aseismic quiet episodes. Three quiet episodes, each lasting about ten years, have been recognized. Currently, it is the fourth quiet episode since 1976. During each episode seismicity occurs in one or two seismic areas or zones. A remarkable change or migration of seismicity in a large-scale space and time interval exists between episodes. This is the main subject of earthquake prediction for a decade period, and also an actual expression of microdynamic status of stress field in the lithosphere.

Ma Zongjin and Gao Weiming

SEISMOTECTONIC MAP SERIES

Seismic activity is the most obvious manifestation of the recent tectonic movement and the continuous development of neotectonism on the surface. Meanwhile, the earthquake has taken place on a certain tectonic setting. The seismotectonic maps show the relationship between seismicity and tectonics, and especially the relationship between earthquakes and neotectonic movements in a visual and imagery pattern. So the compiled maps can serve not only as a basis for seismic intensity regionalization, but also provide the necessary basic materials for studying recent crustal movement and lithospheric dynamics.

The seismotectonic map series consists of 29 maps, i.e. 28 provincial and regional maps compiled in administrative division units, provinces and regions, and one all-China map showing the seismotectonic framework and characteristics in the whole country. The provincial and regional maps reflect objectively the real materials on the static and dynamic characteristics of geologic structures and seismicity in every provinces and regions, and the all-China map is compiled on the basis of synthesis and selection of materials from the provincial and regional maps and some supplements.

A deep analysis of structure of the continental lithosphere is required for studying the lithospheric evolution and dynamic process, and revealing the regularities of earthquake preparation by means of an inhomogeneous dynamic earth model. In order to clarify the seismogeologic conditions for positions of earthquakes the uplifts are identified on the crystalline basement, sedimentary cover and fold belt (zone). The formation and development of basins are the expression of lithospheric evolution and dynamic process. Thus the various basins and depressions are generalized into seven types. The isopach of sediments and rates of subsidence are also distinguished into five types. They may provide a concrete basis for analysis of lithospheric dynamics.

The geophysical data are also important for understanding the structure of continental lithosphere. The data on aeromagnetic anomalies, gravity anomalies, crustal thickenss, heat flow values, focal depths and focal mechanism solutions used in the maps reveal to different extent the stress state, pattern of movement, strain conditions and structural features at different depths and levels of the lithosphere.

The maps reflect the division of active faults, active folds, major lineamants interpreted on the satellite images and from data of observations. The movement rates obtained from deformation, stress and geologic surveys, formation of earthquake-generated faults, Cenozoic magmatic activity, especially the Holocene volcanic eruptions and the distribution of recent volcanic vents and mud volcanoes, and hot springs with temperatures higher than 25°C are the distinct indicators of the neotectonic movement, which are shown respectively in the maps.

The seismicity may be considered as a result of dynamic process of the lithosphere on the recent stress field. From data of instrumental records two periods separated by 1900 for earthquakes are shown in the maps. The seismicity is different in individual provinces and regions, thus it is shown with different methods in the maps for high-seismic areas and lower or less seismic areas. The distribution of focal depths indicates structural characteristics of different levels of the lithosphere. Therefore, the shallow-focus earthquakes are shown in detail by their magnitudes. The data of focal mechanism solutions used in the maps can indicate the nature of the faults where earthquakes occurred, corresponding to the fault activity in the maps.

Cai Wenbo

LITHOSPHERIC DYNAMICS MAP SERIES

China mainland is controlled by two worldwide currently active boundaries, the Western Pacific Island Arc System and the Himalayan-Alpine Orogenic Belt. It is a first-order division for lithospheric dynamics, and continuously displays evolutional features of the two boundaries and the China mainland itself, as well as their interaction.

Seven second-order divisions are recognized according to the structural and dynamic characteristics of the lithosphere in China. They are the Northeast China, North China, Southeast China, Taiwan, South China Sea, Northwest China, and Qinghai-Xizang. The crust in three areas, the Northeast China, the North China, and Southeast China, is thick on the west and thin on the east, from 45 km to about 30~20 km. Da Hinggan-Taihang-Wuling Mts. belt is a big gravitational gradient belt and a sharply-changing crustal thickness belt running NE through the eastern China. Structures in these three areas are mainly NE-trending. In general, they undergo the same dynamic force from the Western Pacific Island Arc. However, a great difference among them exists in the constitution and evolution of the upper crust, developmental history of Mesozoic and Cenozoic tectonic basins, degree of volcanism or magmatism, slip rates on active faults, crustal deformation, and seismicity, showing mutual independence of the three areas. Among which, in North China the lithospheric thickness is thinner, about 70~80km, the crustal structure is more complex, the middle crust is usually characterized by a low velocity zone or alternation of higher and lower velocity layers, and Moho is usually a transition zone from the crust to the mantle. These features are related with a strong extension of the lithosphere and the magmatic intrusions in the North China during the Cenozoic period. The Taiwan area is a part of the Western Pacific Island Arc System, and is closely related to the southeast China. The South China Sea area is the sole area with both continental and oceanic crust, and is characterized by ocean spreading movements.

The two areas in western China together with the western Nei Mongal Plateau constitute an area with thicker crust. Its thickness gradient is in general higher than that in eastern China; its main structures, in particular, the gradient belt of crustal thickness and gravity belt run EW. However, NE- or NW-trending structures in the upper crust are remarkable, which can be contrasted with those in eastern China. The difference between the Northwest and Southwest China is in overall structure. Southwest China is a tectonic block with its accompanying uplift by NS compression. Its crust is convex at the top and concave at the bottom, and the Northwest China is a relative depression where a big fault basin is joined with a band-

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