国家出版基金项目
NATIONAL PUBLICATION FOUNDATION

"十二五"国家重点图书出版规划项目
"十一五""十二五"国家科技重大专项课题资助

中国煤矿瓦斯地质规律及编图

China Coalmine Gas-geologic Laws and Mapping

主编 张子敏 吴 吟
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“十一五”、“十二五”国家科技重大专项课题资助
河南省科技著作项目资助
煤矿安全生产河南省协同创新中心资助

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内 容 提 要

本书系统总结、完善了“瓦斯赋存构造逐级控制理论”，揭示了中国煤矿瓦斯(煤层气)赋存的构造逐级控制规律，提出了中国煤矿瓦斯赋存的区域构造控制10种类型，将全国煤矿瓦斯的赋存分布划分为30个分区，并详细分析了华北、华南、东北、西北和青藏五大地区瓦斯的赋存分布特征。本书全面总结了第二次全国煤矿瓦斯地质图编制成果，编绘了1：250万中国煤矿瓦斯地质图，提出并应用瓦斯地质图法估算瓦斯(煤层气)资源量，估算了22省(区、市)和全国煤矿瓦斯(煤层气)资源量。

本书是瓦斯地质和瓦斯灾害防治理论研究者和工程技术人员的良师益友，也可供从事煤层气勘查开发、安全工程、安全管理等行业技术人员做重要参考。

图书在版编目(CIP)数据

中国煤矿瓦斯地质规律及编图/张子敏，吴吟主编．徐州：中国矿业大学出版社，2014.12

ISBN 978-7-5646-2105-6

Ⅰ．①中… Ⅱ．①张… ②吴… Ⅲ．①煤矿—瓦斯地质规律—地图编绘—中国 Ⅳ．①TD712

中国版本图书馆CIP数据核字(2013)第254754号

书　　名　中国煤矿瓦斯地质规律及编图
主　　编　张子敏　吴　吟
责任编辑　潘俊成　王德福　魏智如
出版发行　中国矿业大学出版社有限责任公司
(江苏省徐州市解放南路　邮编221008)
营销热线　(0516)83885307　83884995
出版服务　(0516)83885767　83884920
网　　址　http://www.cumtp.com　**E-mail**:cumtpvip@cumtp.com
印　　刷　中煤地西安地图印制有限公司
开　　本　890×1240　1/16　**印张** 31.5　**字数** 1110千字
版次印次　2014年12月第1版　2014年12月第1次印刷
总 定 价　1180.00元(含挂图和附图图册)

This book was funded by:
2013 National Publication Fund
"Twelfth Five-Year" National Key book Publishing Plan Projects
"Eleventh Five-Year" and "Twelfth Five-Year" National Science and Technology Major Projects (Grant Nos. 2008ZX05040－005 and 2011ZX05040－005)
Scientific Book Publication Fund of Henan Province
CollaborativeInnovation Center of Coalmine Safe Production, Henan Province

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Chief Reviewers: Ren Jishun　Zhai Guangming

China University of Mining and Technology press
Geological Publishing House

本书编委会

序一

2013年12月14日，星期六，我刚参加了“中国煤矿瓦斯地质规律及编图”项目的验收会，12月19日就收到张子敏教授突然离世的噩耗，感到十分震惊！后来得知，张教授在评审会的当天下午即赶回了焦作，之后连续忙于工作，于17日下午倒在工作岗位上，永远地离开了他的亲人、他的团队、他的同事，离开了他一生热爱的瓦斯地质事业。张子敏教授的过早逝世，使我失去了一位好友，使河南理工大学和中国失去了一位瓦斯地质学的领军人物！这是中国瓦斯地质事业的巨大损失！

中国煤矿瓦斯地质图(1∶250万)及其文字说明——《中国煤矿瓦斯地质规律及编图》，是张子敏教授用生命完成的一部科学巨著。这里既凝聚了河南理工大学和全国22个省(区、市)煤矿瓦斯地质工作者的巨量辛勤劳动，更是张教授一生从事煤矿瓦斯地质科学研究、指导瓦斯灾害防治的珍贵结晶。

张子敏教授在这部著作中最闪亮的创新之处在于，他首先提出了煤矿瓦斯赋存构造逐级控制理论，并用该理论分析、研究、阐述了中国煤矿瓦斯的地质特征和瓦斯分布规律。他把中国煤矿瓦斯赋存的区域构造控制划分为10种类型，把全国煤矿瓦斯的赋存分布划分为30个分区(其中，17个高突瓦斯区，13个瓦斯区)。这样，就从理论与实践的结合上为中国瓦斯地质的理论研究和瓦斯灾害的防治提供了科学指导和正确方向。

从全球范围看，中国位于冈瓦纳与西伯利亚大陆之间，属二者之间的构造转换地带。在显生宙，这里依次受古亚洲洋、特提斯—古太平洋、印度洋—太平洋三大全球性动力体系控制，三大动力体系在这里叠加、复合，使中国所在的东亚地区成为全球多旋回构造运动最明显、地质构造最复杂的区域。从而导致中国是全球煤矿瓦斯(煤层气)地质条件最多样化的区域，亦是瓦斯灾害最严重的国家。张子敏教授用毕生精力终于牵住了构造控制这个“牛鼻子”，抓住了瓦斯地质研究和瓦斯灾害防治的关键地质问题，从而提出了煤矿瓦斯的构造控制思想，为瓦斯地质研究和瓦斯灾害防治奠定了坚实的理论基础。

我衷心期望张教授的后继者们能够沿着他开辟的道路继续前行，从中国大地构造和各地瓦斯地质的实际情况出发，开拓创新，青出于蓝而胜于蓝，把瓦斯地质研究和瓦斯灾害防治进一步引向深入，为中国煤矿瓦斯地质的科学研究和灾害防治做出更大的贡献！

任纪舜

二〇一四年八月十日

序二

中国是世界能源大国，煤、油、气、电等能源的生产和利用在全球均名列前位。煤炭又是我国工业生产和民用生活等各领域均离不开的能源。我国煤炭的生产和利用虽满足了社会需要，但同时也带来了诸多安全环境问题。就全国煤矿“百万吨死亡率”指标而言，我国2009年为0.892，即使2013年降至0.3以下，不仅与澳大利亚(0.014)和美国(0.03)差距很大，而且仍高出第三世界国家3倍以上，这不得不引起我们极大关注。

张子敏、吴吟主编的大型科技专著《中国煤矿瓦斯地质规律及编图》，针对煤矿安全生产和资源开发这一重大问题做了系统深入研究。特别是张子敏教授，他夜以继日地潜心钻研、寻求突破，既注重从学科理论突破入手、厘清问题所在，包括煤矿瓦斯的成因演化和赋存分布，又着眼于生产实践探索，重点破解瓦斯预测和治理的难题。这是对瓦斯地质工作的新开创，其显著特点是——运用板块构造学说、岩石圈理论和瓦斯赋存构造逐级控制理论，分析全国大地构造对含煤盆地和断裂系统的影响，从断裂系统的分布规律到对具体煤盆地的影响，从不同煤层的煤岩组成到煤层含气性的规律，从不同时代含煤盆地分布规律及其特征到全国各主要含煤盆地典型构造和勘探开发历程及其特有规律，不仅厘清了地质构造对煤层和瓦斯赋存的影响，而且还对全国各含煤盆地的煤层气资源做了翔实梳理和计算，同时又对全国煤矿煤与瓦斯突出问题重点做了详尽分析和预测。

煤与瓦斯突出是煤矿生产中经常发生的典型事故之一，长期困扰着煤矿企业的安全生产和煤炭行业的安全监管，是一种非常难以解决而又必须解决的问题。煤层瓦斯是怎样形成的？煤与瓦斯突出是在什么条件下发生的？如何有效控制和做好预防工作？在这一系列亟待解决问题方面，以张子敏教授为代表的很多专家学者做了大量工作。他们从瓦斯赋存和煤与瓦斯突出形成机理出发，系统梳理了全国含煤盆地的地质构造特征，对每一个盆地均按不同的断裂系统进行分类，分析每一条断裂对煤层和瓦斯赋存的影响以及可能发生的问题，终于取得了一系列可喜的成果，为降低我国煤矿百万吨死亡率做出了可贵的贡献。煤矿瓦斯(煤层气)又是一种重要的清洁能源。我国的煤储层赋存有多少瓦斯(煤层气)？能否开发出来？怎样才能更好地变废为宝利用起来？在这方面，张子敏教授团队也做了翔实的调查和深入探索，为全国煤层气的勘查和开发提供了有利的线索和科学根据。他们的这项《中国煤矿瓦斯地质规律及编图》成果，不仅对中国的煤矿安全生产具有很强的指导作用，而且对煤层气的勘查理论研究和开发实践亦有较大的参考价值。

我每次与张子敏教授进行学术交谈，都能强烈地感受到他研究破解上述重要问题的热情和执著精神，让我感动不已！同时我也感到，按照他们的这种思路和精神坚持下去，总会解决中国煤矿瓦斯地质中的很大问题的。我常劝他，要放松一些才能坚持做下去，别太紧张，不要把弦绷得太紧。真是万万没有想到，就在张子敏教授领导的团队终于完成这项伟大工作之际，却同时传来了他突然不幸去世的消息，真是令人十分悲痛、万分惋惜！他把毕生都献给了祖国的瓦斯地质事业！他终生潜心研究、孜孜不倦、埋头苦干和任劳任怨的科学探索精神，值得我们永远珍惜、怀念和学习！

以上文字，作为张子敏教授的临终大作《中国煤矿瓦斯地质规律及编图》之序，以作纪念。相信他曾领导的团队能秉承他的工作精神，继续按照他既定的工作目标把他未竟的事业持续进行下去，不断取得丰硕成果！

二〇一四年八月三日

前　言

我国是世界上煤矿自然灾害最严重的国家，2005年煤矿百万吨死亡率高达2.81。经过近几年的治理，2010年下降至0.749，但与世界先进国家相比差距仍然很大。2009年世界主要产煤国家煤矿百万吨死亡率的基本情况是——澳大利亚，0.01；美国，0.018；南非，0.07；印度，0.176；俄罗斯，0.19。我国煤矿百万吨死亡率大体是澳大利亚的75倍、美国的42倍、印度的4.3倍、俄罗斯的3.9倍。在煤矿自然灾害中，瓦斯灾害被称做煤矿安全的“第一杀手”。瓦斯储藏在煤层中，只要开采煤炭就会有瓦斯释放。瓦斯喷出、煤与瓦斯突出是矿工生命安全的最大威胁。由此可见，我国治理瓦斯灾害的任务相当繁重。

目前，我国煤矿瓦斯灾害治理面临的形势可以概括为：一方面，由于瓦斯灾害涉及瓦斯成因的复杂类型和瓦斯赋存的复杂地质环境，因而治理难度大；另一方面，煤炭开采和煤层气开发利用又使瓦斯灾害治理的任务变得十分突出。按照国家煤层气（煤矿瓦斯）开发利用“十二五”规划，到2015年我国煤层气产量将达到300亿m^3，煤矿瓦斯事故起数和死亡人数要比2010年下降40%以上。显然，从事煤矿瓦斯治理的科技工作者和工程技术人员面临的形势十分紧迫。

解决煤矿瓦斯灾害问题，归根结底要依靠科学的瓦斯治理理论方法体系。瓦斯地质编图是被实践证明了的治理瓦斯灾害行之有效的科学方法和重要途径。本部专著在全面总结中国煤矿瓦斯地质研究成果的基础上，对中国煤矿瓦斯地质图编制的理论依据、工作程序、编制方法、编制结果等做了系统规划和设计，为全面开展全国和各省（区、市）的煤矿瓦斯地质图编制提供了相应的编图理论和方法指导。

一、中国煤矿瓦斯地质编图的基本理论依据

瓦斯地质学是我国科技工作者在治理瓦斯灾害领域的研究实践中开创的一门新兴边缘学科。它从地质构造与瓦斯赋存的关系入手，解决了瓦斯（煤层气）赋存分布规律与分布特征的问题，为煤矿瓦斯治理提供了重要的理论基础。依据瓦斯地质研究揭示的瓦斯赋存规律，开展瓦斯地质编图，从宏观、微观等不同层次领域找出中国各级区域层次的瓦斯赋存规律，对指导煤矿安全生产和煤层气开发具有重大意义。因此，煤矿瓦斯地质图编制的基本理论依据是瓦斯地质学。

以下是本书提出的对中国煤矿瓦斯地质图编制具有纲领性理论指导意义的几个瓦斯地质学观点。

① 中国是世界上含煤盆地地质条件最为复杂的国家。含煤盆地及其瓦斯（煤层气）赋存分布状态，是地质构造演化的结果。板块构造运动控制着造山活动，控制着含煤盆地的形成、隆起、拗陷、挤压、拉张、裂陷、岩浆活动以及水文地质等事件的特征。形成于中国大陆不同地质时代的含煤地层所在大地构造位置不同、板块构造作用程度不同、区域地质构造演化背景不同，使得各盆地的沉积环境、地应力场、温度场等不同，进而导致其煤岩体变形作用、煤化作用等均不尽相同。大规模的构造挤压、剪切活动，会使煤层产生大规模的变形和地球物理化学作用，并使煤体发生粉碎性破坏而形成复杂的瓦斯突出煤体；大规模的构造岩浆活动会使煤层煤化作用增强，形成的瓦斯（煤层气）含量增加，或者形成高阶无烟煤而不吸附瓦斯；大规模的构造拉张、裂陷活动和大规模的构造隆起剥蚀作用，都会使煤层瓦斯（煤层气）大量释放。

② 中国含煤地层和煤层瓦斯（煤层气）赋存的研究存在着一个极其复杂的大地构造演化

背景问题。我国主要有7个地质时代的含煤地层——分别是石炭系、二叠系、三叠系、侏罗系、白垩系、古近系和新近系，它们分布于中朝、扬子、塔里木三个小克拉通、众多微陆块和造山带中。含煤地层经历了海西、印支、燕山、喜马拉雅多期次构造运动，大地构造及其演化依次受古亚洲洋、特提斯—古太平洋和印度洋—太平洋三大动力学体系的控制。按构造属性，微陆块分为亲西伯利亚、亲冈瓦纳、亲古中华三个陆块群；造山带分属于古亚洲、特提斯和环(滨)太平洋三大造山区。在地质历史上，它们位于冈瓦纳和西伯利亚两个巨型大陆的交接、过渡地带，属两者之间的转换构造域。中国大陆的地球动力学演化过程是在古亚洲洋和特提斯—古太平洋消失前发生的造山作用，并不是西伯利亚和冈瓦纳等巨型陆块间直接相连的强(硬)碰撞造山，而是它们的复杂大陆边缘的小陆块和微陆块的碰撞造山(任纪舜，1999)。复杂的大地构造演化背景，导致了极为复杂的中国煤层瓦斯赋存构造控制特征。

③ 中国煤与瓦斯突出灾害最为严重的根本原因，在于含煤地层经历多期造山作用后构造挤压剪切破坏强烈。这种强烈的破坏作用导致瓦斯突出煤体发育，煤矿瓦斯(煤层气)渗透性低、抽采难度大，瓦斯灾害频发。1990年，我国共有煤与瓦斯突出矿井274对，发生煤与瓦斯突出10 867余次。截至2011年，突出矿井增加到1146对，发生煤与瓦斯突出超过16 741次，平均每年新增突出矿井41对，每年发生煤与瓦斯突出事故280余次。

二、中国煤矿瓦斯地质编图的目的和历史基础

中国煤矿瓦斯地质编图，根本目的就是要在宏观、微观等不同层次区域内厘清煤矿瓦斯(煤层气)赋存的分布特点，并以瓦斯地质图的形式生动地再现出来，用以指导煤炭开采和煤层气开发，预防和治理瓦斯灾害，确保煤矿生产安全。

在我国，瓦斯地质编图工作已有30余年历史。鉴于中国煤矿瓦斯灾害防治难度大，瓦斯地质创始人、原焦作矿业学院(现为河南理工大学)教授杨力生先生早在上世纪七八十年代就提出了编制煤矿瓦斯地质图的想法。1983年，在煤炭工业部时任主管领导赵全福、付建华的大力支持下，焦作矿业学院杨力生、张子敏、陈名强、张克树申请承担了"编制全国煤矿瓦斯地质图"项目。该项目不仅得到了中国矿业学院(现为中国矿业大学)周世宁、陆国桢、钱鸣高，平顶山矿务局张铁岗，山东矿业学院(现为山东科技大学)王大曾，中国煤田地质局王宗、袁三畏，山西煤田地质局董乾泰，甘肃煤田地质局王汝轶，江西煤田地质局王涛，煤炭科学研究总院西安分院赵景斌、邱林和抚顺分院王佑安、于良臣等众多专家的支持，还得到了时任国家煤炭工业局局长张宝明、王显政等领导的高度重视以及以广西煤炭厅王同良等为代表的全国25个省(区、市)煤炭厅(局)主要领导的大力支持。此次编图工作，在杨力生教授的带领下，全国共编制了500余幅矿井、125幅矿区、25幅省区瓦斯地质图，1990年完成并于1992年出版专著《1∶200万中国煤层瓦斯地质图》和《1∶200万中国煤层瓦斯地质图编制》。《1∶200万中国煤层瓦斯地质图》使用煤炭工业部1980年编制的《1∶200万中国煤田地质图》、《1∶200万中国煤田预测图》和黄汲清指导中国地质科学院地质研究所构造地质室于1979年编制的《1∶400万中国大地构造图》作为地理底图，将中国煤层瓦斯的分布划分为89个瓦斯带(含高瓦斯带36个，低瓦斯带53个)和20个瓦斯分区。1990年12月，经煤炭部技术司组织的以赵全福为主任委员、贾悦谦和关士聪为副主任委员的鉴定委员会鉴定，《1∶200万中国煤层瓦斯地质图》为国内首创，达到国内领先水平。这一重要的学术成果，成为中国煤矿瓦斯地质图编制的历史基础。

三、国家发改委、国家能源局决定开展全国煤矿瓦斯地质图编制工作

自1990年第一次全国煤矿瓦斯地质编图工作至今已时过20余年，世界经济和能源均处在一个高速发展的阶段。中国的煤炭产量由原来的10亿t/a提高到30亿t/a以上；全国矿井从不足1000对发展到万余对；开采深度每年以10～20 m的速度增加，由原来的五六百米发展到千米深井；最大井型由原来的年产300万t、400万t发展到千万吨级以上。瓦斯预测和防治难度越来越大，平均每年新增突出矿井40余对，煤与瓦斯突出灾害频发。

有鉴于此，国家发改委、国家能源局决定开展新一轮的全国煤矿瓦斯地质图编制工作。

2009年4月15日，国家能源局下发《关于组织开展全国煤矿瓦斯地质图编制工作的通知》（国能煤炭〔2009〕117号）文件，要求成立全国煤矿瓦斯地质图编制工作领导小组和技术工作组，组织开展全国煤矿矿井、矿区、省（区、市）和全国煤矿瓦斯地质图编制工作。国家能源局煤炭司司长方君实任领导小组组长，河南理工大学张子敏教授任技术工作组组长。技术工作组制定了全国煤矿瓦斯地质图编制实施方案和矿井、矿区、省（区、市）煤矿瓦斯地质图编制方法。

2009年6月8～9日，全国煤矿瓦斯地质图编制工作启动暨培训会在河南省焦作市召开，国家能源局副局长兼总工程师吴吟做重要讲话，充分强调了瓦斯地质编图工作的重要性。他指出："编制煤矿瓦斯地质图是治理瓦斯的基础性工作。瓦斯地质图是煤矿瓦斯地质资料最好的档案，既是多年瓦斯预测、灾害防治、瓦斯抽采实践的高度集中，又是指导之后准确预测瓦斯资源量、涌出量、突出危险性的重要理论和实践依据。编制煤矿瓦斯地质图，高度概括多年积累的瓦斯地质信息，把地质活动对瓦斯赋存的影响搞清楚，把无形的规律形象地反映在图上，把瓦斯治理的难点、重点把握准，瓦斯预测和治理才能有的放矢。大量的实践证明，瓦斯地质图是瓦斯治理研究、交流、决策的重要技术平台，是治理瓦斯、预防事故的重要基础资源。"这次全国煤矿瓦斯地质图编制工作启动暨培训会共有来自全国26个产煤省（区、市）的代表和专家500余人参加。

2010年5月21日，国家能源局主持的全国煤矿瓦斯地质图编制工作进展汇报会再次在河南省焦作市召开，国家能源局煤炭司司长方君实主持会议并做了重要讲话。会后，国家能源局下发了"国能煤炭〔2010〕180号"文件——《关于印发全国煤矿瓦斯地质图编制工作进展交流会会议纪要的通知》。2011年8月8日，国家能源局下发《关于开展省（区）和矿区煤矿瓦斯地质图评审工作的通知》（能煤函〔2011〕41号文件），并由全国煤矿瓦斯地质图编制工作技术组成立了以张子敏为组长，高建良、曾勇为副组长的评审验收领导小组，负责对各省（区）和矿区煤矿瓦斯地质图的评审验收。

鉴于广东、浙江、湖北三省仅有一些地方和乡镇小型矿井，三省没有再编制省级瓦斯地质图。

截至2011年8月底，全国共完成22个省（区、市）煤矿瓦斯地质图、173个矿区瓦斯地质图、2792对矿井瓦斯地质图和相应的研究报告。在这次编图工作中，根据瓦斯地质学原理和掌握资料的实际情况（瓦斯地质资料截止时间为2011年8月底），确定了中国煤矿瓦斯赋存地质构造控制规律的10种类型，并将全国煤矿瓦斯的赋存分布划分为30个分区〔其中，17个高突瓦斯区、13个（低）瓦斯区〕，编制了《1：250万中国煤矿瓦斯地质图》，并于2011年11月11日在合肥全国煤矿瓦斯防治会议上首次展出，同年12月11日在成都中国煤炭工业协会举办的全国煤矿瓦斯突出防治会议上进行了重点介绍。

《1：250万中国煤矿瓦斯地质图》转绘了全国1146对突出矿井、1988对高瓦斯矿井点；转绘了全国17个高突瓦斯区、13个（低）瓦斯区中的所有矿区名称、最大突出强度点、最小始突深度点、最大瓦斯压力点、最大瓦斯含量点；标注了每个分区的瓦斯（煤层气）资源量、瓦斯风化带深度、煤与瓦斯突出始突深度和瓦斯赋存地质构造控制类型等。图中还编制了"中国煤矿瓦斯（煤层气）分布特征汇总表"，可以看到全国最集中、最敏感的瓦斯信息，如突出矿井总对数、突出总次数、瓦斯含量最大值、瓦斯压力最大值和煤层气资源量等；编制了"中国煤矿瓦斯（煤层气）赋存分区划分特征一览表"，可以看到全国30个瓦斯分区中每个分区的瓦斯地质规律、瓦斯涌出、瓦斯突出、瓦斯赋存的特征，瓦斯灾害防治的重点和难点，煤层气开发利用的有利区和不利区；编制了"中国煤矿瓦斯赋存分区与矿井隶属关系一览表"，可以直接查到全国1146对突出矿井、1988对高瓦斯矿井、173个矿区的名称及其瓦斯地质信息。

本著作为"十二五"国家重点图书出版规划项目，获得了2013年度国家出版基金资助、"十一五"和"十二五"国家科技重大专项课题（2008ZX05040—005和2011ZX05040—005）资

助、河南省科技著作出版资金资助以及煤矿安全生产河南省协同创新中心资助。中国科学院院士任纪舜和中国工程院院士翟光明担任本书主审。借此机会，感谢所有参与新一轮全国煤矿瓦斯地质图编制工作的教授、专家、学者及广大煤矿技术工作人员；感谢长期关心和支持瓦斯地质发展的贾承造、任纪舜、滕吉文、姚振兴、袁亮、翟光明、张铁岗、周世宁等院士和已故的杨起院士；感谢中国煤炭工业协会王显政会长和刘峰副会长；感谢程远平、陈忠胜、丁安平、范宁民、胡千庭、胡秋祥、姜智敏、焦蓬华、李平、黎石华、梁俊方、刘见中、刘社虎、刘修源、卢鉴章、马振林、宁宇、屈先朝、申宝宏、宋志敏、万清生、王凯、王生全、魏国营、卫惠宣、文世元、夏培兴、殷作如、俞启香、余庆、杨曙光、张泓、张明杰、张群、张新民、张玉贵、张子戌、曾勇、周建、周心权等教授和专家。

在编制《1：250万中国煤矿瓦斯地质图》工作中，研究生王朝帅、杨付领、高卫国等做了大量资料汇总和插图清绘工作；在《中国煤矿瓦斯地质规律及编图》编写过程中，研究生余红光、彭磊、王保军、林辰、王泽惠、别文博、高志松、张孝广、张亚洲、王天瑜、解振、张玉柱、司成林、马韶萍、郭昕曜、董雁梧、冉小勇、郇璇、马帅、王远声、张倩、李明明、王建康、杜冬冬、董林升、李永生、陶东东、王林征、张凯、彭阳阳、陈坤、梁松杰等做了大量资料统计整理和插图清绘工作。

中国煤矿瓦斯地质图编制委员会
二〇一四年十月

Preface

China is the country where coalmine natural disasters are most severe in the world. An index for mortality rate per million tons of coal production was up to 2.81 in 2005. After several years of gas controlling, the index was reduced to 0.749 in 2010. However, the gap is still large compared to that of the developed countries in the world. A general situation of the mortality rate per million tons of coal production was as follows in major coal producing countries in 2009: Australia 0.01, USA 0.018, South Africa 0.07, India 0.176 and Russia 0.19. The index of China is roughly 75 times of that in Australia, 42 times in USA, 4.3 times in India or 3.9 times in Russia. Among the natural disasters in coalmines, gas hazard is "the first killer" for coalmine safety. Gas occurrence in coal seams is released during mining. Gas burst or coal-gas outburst is the greatest threat to miners' safety. Therefore, control and mitigation of gas disasters were a very heavy and challenging task in China.

The current situation for gas-disaster control in China could be summarized as follows: On one hand, since gas disasters involve various types of gas formation and complex geological environment of gas occurrence, control of gas disasters has been very difficult; On the other hand, coal mining and coalbed methane (CBM) exploitation could make gas-disaster control more prominent. According to the 12^{th} Five-Year Plan for Exploitation and Utilization of Coalbed Methane (Coalmine Gas) in China, the CBM production in China will reach 300 billion m^3 by 2015, and the number of accidents and deaths due to gas disasters will be reduced by more than 40%, compared to those in 2010. Obviously, the task in control and mitigation of coalmine gas disasters is very urgent faced by scientists and engineers in this field.

Control and mitigate coalmine gas disasters must rely on the gas-geological theory and method ultimately. Mapping of gas geology had been proved to be an effective method and important mean for control of gas disasters. Based on the comprehensive summary of research achievements on coalmine gas geology in China, the theoretical basis, working procedures, methods and achievements for drawing of coalmine gas-geological maps in China were specified and designed systematically in this book, which had been used to mapping of coalmine gas-geology in various provinces (districts and cities) and the whole country.

1. Fundamental theoretical basis for coalmine gas-geological mapping in China

Gas geology is an emerging frontier subjectinitiated by scientists and technicians working on researches and practices in control of gas disasters. Starting from the relationship between tectonic structures and gas occurrence, it cloud be used to solve problems related with the distribution laws and characteristics of coalmine gas (CBM) occurrence, which provides an important theoretical basis for coalmine gas controlling. Gas-geological mapping could be carried out based on the gas occurrence laws and gas geology studies. The gas occurrence laws at various scale regions in China are identified from macroscopic and microscopic levels, which is great significance for safety production and CBM exploitation in coalmines. Therefore, the fundamental theoretical basis for gas-geological mapping in coalmines is gas geology.

The following are some aspects proposed from viewpoint of gas geology in this book which have programmatic significance to mapping of coalmine gas geology in China:

① China is a country which has the most complicated geological conditions of coal basins in the world. The distribution of coal basins and coalmine gas (CBM) occurrence were the result of tectonic evolution processes. Plate tectonics control the orogenic activities, the characteristics of formation, uplifting, depression, extrusion, tension, taphrogeny, magmatic activities and hydrogeology of coal basins. Due to the difference in tectonic locations, degree of plate tectonics and regional tectonic evolution background for coal seams are different at various coal basins in Mainland China formed at different geological areas, the sedimentary environment, stress field, the temperature field, and so on,, which further lead to difference in coal deformation and coal metamorphism. Large-scale tectonic extrusion and shear activities result in large-scale deformation and geophysical-chemical reactions in coal seams, and tectonic coal prone to gas outburst forming due to coal mass fragmentation. Large-scale tectonic and magmatic activities lead to intensified coalification, higher gas content or highest-rank anthracite without adsorptive. Large-scale tectonic tension and taphrogeny and large-scale tectonic uplift and erosion also lead a great amount of coal seam gas releasing.

② Extremely complicated tectonic evolution background was encountered in the study on coal seams and coalmine gas (CBM) occurrence in China. The coal seams in China, mainly formed in 7 geological eras, namely Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Paleogene and Neogene periods, which were distributed in the three small cratons of Zhongchao, Yangtze and Tarim, many micro continental massifs and orogenic belts. The coal seams had undergone tectonic movements in multiple periods, such as Hercynian, Indo-China, Yanshan and Himalayan tectonic movements. Tectonic structures and their evolution were controlled by three dynamic systems in sequence, namely the ancient Asian Ocean, the Tethys Paleo-Pacific Ocean and the Indian Ocean-Pacific Ocean. In terms of tectonic properties, the micro continental massif could be divided into Siberia affiliated blocks, Gondwana affiliated blocks and ancient China affiliated blocks. The orogenic belts belong to three orogenic regions, namely ancient Asia, Tethys and Circum (Marginal) Pacific. In the geological history, they were located at the border and transition zone between the two giant continents of Gondwana and Siberia, which were the transitional tectonic regions between the two continents. The geodynamic evolution process of mainland China was the orogenic process before the ancient Asian Ocean and Tethys Paleo-Pacific Ocean disappeared. It was the result of collisional orogeny between at the small continental blocks and micro continental massifs at the continental margins, instead of direct strong (hard) collisions between giant Siberia and Gondwana massifs (Ren Jishun, 1999). The complex tectonic evolution background led to the extremely complicated tectonic controlling characteristics for coal seam gas occurrence in China.

③ Theessential cause of coal-gas outburst disasters in China lies in intensive failure of coal seams due to tectonic extrusion and shear in the multiple orogenic periods. The failure led to formation of tectonic coal highly prone to coal-gas outburst, low permeability of CBM, great difficulty in exploitation and frequent gas disasters. Before 1990, there were 274 mines prone to coal-gas outburst, and more than 10867 coal-gas outburst events happened in China. However, the number of gas outburst mines increased to 1146 and more than 16741 coal-gas outburst accidents occurred in 2011. In average, the number of gas outburst mines was increased by 41 and over 280 coal-gas outburst events every year.

2. Purposes and historicalfoundation of coalmine gas-geological mapping in China

Theessential purpose of coalmine gas-geological mapping in China is to clarify the distribution characteristics of coalmine gas (CBM) occurrence in various fields at macroscopic and microscopic levels, and being used to vividly reproducing gas-geological maps which could guide coal mining, CBM exploitation and gas disasters mitigation.

Gas-geological mapping in China has a history of more than 30 years. In view of great difficulties in coalmine gas disasters control in China, Professor Yang Lisheng of Jiaozuo College of Mining (now Henan Polytechnic University), the founder of gas geology studying in China, put forward an idea of coalmine gas-geological mapping early in 1970s. In 1983, under tremendous support of the former leader-in-charge from Ministry of Coal Industry, Mr. Zhao Quanfu and Mr. Fu Jianhua, Professors Yang Lisheng, Zhang Zimin, Chen Mingqiang and Zhang Keshu awarded the project of "Mapping of coalmine gas geology in China". This project not only received support from Professors Zhou Shining, Lu Guozhen, and Qian Minggao of China College of Mining (now China University of Mining and Technology), Mr. Zhang Tiegang of Pingdingshan Mining Administration, Professor Wang Dazeng of Shandong College of Mining (now Shandong University of Science and Technology), Mr. Wang Zong and Yuan Sanwei of China National Administration of Coal Geology, Mr. Dong Qiantai of Shanxi Administration of Coal Geology, Mr. Wang Ruyi of Gansu Administration of Coal Geology, Mr. Wang Tao of Jiangxi Administration of Coal Geology, Mr. Zhao Jingbin and Qiu Lin of Xi'an Branch of China Coal Research Institute, Mr. Wang You'an and Yu Liangchen of Fushun Branch of China Coal Research Institute, but also attracted great attention of some government leaders, such as Mr. Zhang Baoming and Wang Xianzheng, the former directors of National Coal Industry Administration, and strongly supported by the major leaders of Coal Industry Administration from 25 provinces (districts or municipalities), represented by Mr. Wang Tongliang of Guangxi Coal Industry Administration. Coalmine gas geological mapping work was led by Professor Yang Lisheng. More than 500, 125 and 25 gas-geological maps have been compiled for mines, coalfields and provinces respectively. The monographs titled "1 : 2000000 Coal Seam Gas-Geological Map of China" and "Compilation of 1 : 2000000 Coal Seam Gas-Geological Map of China" were completed in 1990 and published in 1992. With "1 : 2000000 Coalfield Geological Map of China" and "1 : 2000000 Predicted Distribution Map of Coalfields in China" compiled by Ministry of Mining Industry in 1980, and the base maps from "1 : 4000000 Map of Tectonic Structures in China" compiled by Division of Tectonics, Chinese Academy of Geological Sciences, supervised by Professor Huang Jiqing in 1979. The map namely "1 : 2000000 Coal Seam Gas-Geological Map of China", divided distribution of coal seam gas geology in China into 89 gas zones (including 36 high gas content zones and 53 low gas content zones) and 20 gas subareas. As accredited by the appraisal committee organized by Technology Division, Ministry of Coal Industry in December 1990, including Mr. Zhao Quanfu, Jia Yueqian and Guan Shicong, the Map was the initiative and reached the domestic leading level in China. This important achievement has been the historical foundation for coalmine gas geological mapping in China.

3. National Development and Reform Commission and National Energy Administration decided to carry out national coalmine gas-geological mapping in China

It has been more than 20 years since the first national coalminegas-geological mapping in 1990. Nowadays, China's coal production has been increased from 1 billion t/a to above 3 billion t/a; the number of mines in China has been increased from less than 1000 to more than 10000; the mining depth increases at rate of 10～20 m per year from 500～600 m to more than 1000 m; The production capacity of the large scale mine has increased from 3～4 million tons to above 10 million tons. Gas prediction and gas control have become more difficult. In average, more than 40 mines per year are added to the list of mines experiencing coal-gas outburst. Coal-gas outburst disasters occur frequently.

Therefore, National Development and Reform Commissions and National Energy Administration decided to launch a new round of coalmine gas-geological mapping in China.

On 15 April 2009, National Energy Administration issued "Notice on organizing and conducting national coalmine gas-geological mapping" (NEA Coal Document No. (2009) 117). It requested to establish a leading group and a technical working group for coalmine gas-geological mapping in China, and to organize and conduct mapping of coalmines, coalfields and provinces (districts or municipalities) and mapping of coalmine gas geology in China. Mr. Fang Junshi, the director general of Coal Division of National Energy Administration, was the leader of the leading group, and Professor Zhang Zimin of Henan Polytechnic University, was appointed as the leader of the technical working group. The technical working group drafted the implementation scheme for coalmine gas geological mapping in China and the method for mapping of gas geology in various mines, coalfields and provinces (districts or municipalities) range.

During 8～9 June 2009, National Conference on Launching of Coalmine Gas-Geological Mapping cum

Training was held in Jiaozuo, Henan Province. Mr. Wu Yin, the deputy director and chief engineer of National Energy Administration delivered an important speech. He stressed that "Coalmine gas-geological mapping is a fundamental work for gas control. And the maps are the best archives for coalmine gas-geological data, which were not only a high concentration of practices in gas prediction, disaster prevention and gas extraction, but also could provide important theoretical and practical bases for guiding accurate prediction of the amount of gas resources, emission rate and gas outburst proneness in the future. Drawing of coalmine gas-geological maps highly summarized the gas geology information accumulated over the years. It could clarify the effects of geological activities on gas occurrence and reflect the invisible laws on the map vividly. Only if the difficulties and focuses on gas control are specified, can gas prediction and gas control have a definite object. A great number of practices have proven that gas-geological maps were the important technical platform for researches, exchange and decision-making on gas control, and the important fundamental resource for gas control and accident prevention." Wu's speech fully revealed the significance of gas-geological mapping. More than 500 delegates and experts from 26 coal producing provinces (districts or municipalities) participated this conference.

On 21 May 2010, the meeting on progress of national coalmine gas-geological mapping was hold by National Energy Administration again in Jiaozuo, Henan Province. Mr. Fang Junshi, the director general of Coal Division of National Energy Administration, presided at the meeting and delivered an important speech. After the meeting, National Energy Administration issued "NEA Coal Document No. (2010)180" - "Notice on dissemination of minutes of the meeting on progress of national coalmine gas geology". On 8 August 2011, National Energy Administration issued "Notice on carrying out assessment of gas-geological maps for various provinces (districts) and coalfields" (Energy Coal Letter No. (2011)41). An evaluation and acceptance group was set up by the technical working group of national coalmine gas-geological mapping. The group head was Professor Zhang Zimin, and deputy heads were Professors Gao Jianliang and Professors Zeng Yong. The group was in charge of review and acceptance inspection of coalmine gas-geological maps for various provinces and coalfields.

Because of some local small-scale mines, those provinces namely Guangdong, Zhejiang and Hubei, were not compiled gas-geological maps at the provincial level.

By the end of August 2011, coalminegas-geological maps for 22 provinces (districts or municipalities), 173 coal fields, 2792 coalmines and the corresponding research reports had been completed. During this round of mapping work, according to the theory of gas geology and actual data collected (gas geology data collected up to the end of August 2011), 10 types of regional tectonic controlling laws of coalmine gas occurrence in China were specified. The distribution of coalmine gas occurrence was divided into 30 zones (including 17 high gas and outburst zones and 13 gas zones). "1 : 2500000 Coalmine Gas-Geological Map of China" was compiled. The map was first presented at National Conference on Control and Prevention of Coalmine Gas held in Hefei city, Anhui Province on 11 November 2011, then was highlighted at National Conference on Coalmine Gas Outburst Control and Prevention held by China National Coal Association in Chengdu on 11 December 2011.

The data, such as 1146 mines with coal-gas outburst, 1988 mines with high gas content, the maximum gas outburst intensity points, the minimum outburst initiation depth, the maximum gas pressure points, the maximum gas content points for all the mines in 17 high gas and outburst zones and 13 gas zones are specified in "1 : 2500000 Coalmine Gas-Geological Map of China". Meanwhile, the amount of coalmine gas (CBM) resources, the depth of gas weathered zones, the depth where coal-gas outburst initiate, and the regional tectonic controlling type for gas occurrence etc., are marked in the map. In addition, a summary table for the distribution characteristics of coalmine gas (CBM) in China is presented in the map. It shows the most concentrated sensitive gas information, such as the total number of mines subject to gas outburst, the total number of gas outburst event, the maximum gas content, the maximum gas pressure, and the amount of CBM resources etc. A complete list of zonation characteristics of coalmine gas (CBM) occurrence in China is compiled, which shows the laws of gas geology, the characteristics of gas emission, the tendencies of gas outburst, and the distributions of gas occurrence for each zone, the foci and the difficulties in control of and prevention of gas disasters, favorable zones and unfavorable zones for CBM exploitation. Furthermore, a complete list of subordinate relationship between coalmine gas occurrence zones and coalmines in China is also presented, from which the names of 1146 mines with gas outburst, 1988 mines with high gas content and 173 coalfields and the relevant gas geology information could be found directly.

As one of "Twelfth Five-Year" National Key Publication Plan Projects, this book was financially supported by 2013 National Publication Fund, "Eleventh Five-Year" and "Twelfth Five-Year" National Science and Technology Major Projects (Grant Nos. 2008ZX05040-005 and 2011ZX05040-005), Scientific Book Publication Fund of Henan Province and Collaborative Innovation Center of Coalmine Safe Production, Henan Province. Academician Ren Jishun, Chinese Academy of Sciences and Academician Zhai Guangming, Chinese Academy of Engineering, are the chief reviewers of this book. Taking this opportunity, we'd like to thank the professors, experts, scholars and technical staff working at various coalmines who have participated in this new round of national coalmine gas-geological mapping, and express our gratitude to Academicians Jia Chengzao, Ren Jishun, Teng Jiwen, Yao Zhenxing, Yuan Liang, Zhai Guangming, Zhang Tiegang and Zhou Shining, and the late academician Yang Qi; Mr. Wang Xianzheng, President of China National Coal Association and Mr. Liu Feng, Vice-president of China National Coal Association; Professors Cheng Yuanping, Chen Zhongsheng, Ding Anping, Fan Ningmin, Hu Qianting, Hu Qiuxiang, Jiang Zhimin, Jiao Penghua, Li Ping, Li Shihua, Liang Junfang, Liu Jianzhong, Liu Shehu, Liu Xiuyuan, Lu Jianzhang, Ma Zhenlin, Ning Yu, Qu Xianchao, Shen Baohong, Song Zhimin, Wan Qingsheng, Wang Kai, Wang Shengquan, Wei Guoying, Wei Huixuan, Wen Shiyuan, Xia Peixing, Yin Zuoru,. Yu Qixiang, Yu Qing, Yang Shuguang, Zhang Hong, Zhang Mingjie, Zhang Qun, Zhang Xinmin, Zhang Yugui, Zhang Zixu, Zeng Yong, Zhou Jian and Zhou Xinquan, who have always concerned and supported the development of gas geology studies.

During compilation of "1 : 2500000 Coalmine Gas-Geological Map of China", postgraduates Wang Chaoshuai, Yang Fuling, and Gao Weiguo etc., did a lot of work on data collection and preparation of illustration figures. During compilation of "Distribution and Mapping of Coalmine Gas Geology in China", postgraduates Yu Hongguang, Peng Lei, Wang Baojun, Lin Chen, Wang Zehui, Bie Wenbo, Gao Zhisong, Zhang Xiaoguang, Zhang Yazhou, Wang Tianyu, Xie Zhen, Zhang Yuzhu, Si Chenglin, Ma Shaoping, Guo Xinyao, Dong Yanwu, Ran Xiaoyong, Huan Xuan, Ma Shuai, Wang Yuansheng, Zhang Qian, Li Mingming, Wang Jiankang, Du Dongdong, Dong Linsheng, Li Yongsheng, Tao Dongdong, Wang Linzheng, Zhang Kai, Peng Yangyang, Chen Kun and Liang Songjie etc., did a lot of work on statistics and collation of data and preparation of illustration figures.

Committee for Coalmine Gas-Geological Mapping
October 2014

目　次

第一编　编制瓦斯地质图的说明

第二编　中国煤矿瓦斯赋存构造逐级控制规律