



中国地质调查成果 CGS 2018-004

“十三五”国家重点出版物出版规划项目

南美洲地质矿产 与矿业开发

SOUTH AMERICA GEOLOGICAL MINERALS AND MINING DEVELOPMENT

陈玉明 张 潮 陈秀法 陈喜峰 赵宏军 崔敏利 等编著
张伟波 王秋舒 吴林强 王靓靓 元春华



中国地质调查成果 CGS 2018-004
“十三五”国家重点出版物出版规划项目

南美洲地质矿产与矿业开发

SOUTH AMERICA GEOLOGICAL MINERALS AND MINING DEVELOPMENT

陈玉明 张 潮 陈秀法 陈喜峰
赵宏军 崔敏利 张伟波 王秋舒 等编著
吴林强 王靓靓 元春华



 中国地质大学出版社
CHINA UNIVERSITY OF GEOSCIENCES PRESS

内容简介

本书是作者多年在南美洲从事勘查实践和实地调查基础上的综合研究成果。本书系统地收集了南美洲地质矿产、资源开发、矿业政策、投资环境等资料,总结了南美洲主要构造单元/成矿区带、优势矿产资源、成矿地质背景和成矿规律,结合国内经济发展对能源和矿产资源的需求,重点介绍了油气、铜、金银、铅锌、锡、铁、锂、铀和铝土矿等矿种的典型矿床、成矿规律、勘查开发程度,以及在南美洲经营的主要矿业公司;以成矿规律认识为基础,分析了优势矿产的资源潜力,圈定成矿远景区;分析对比了南美洲各国矿业投资环境,总结了矿业开发领域有利的和不利的因素等。

本书内容丰富,资料和信息翔实可靠,可供从事境外矿产资源勘查、投资以及境外地质矿产研究、教学相关人员参考使用。

图书在版编目(CIP)数据

南美洲地质矿产与矿业开发/陈玉明等编著. —武汉:中国地质大学出版社,2018.7

ISBN 978-7-5625-3968-1

I. ①南…

II. ①陈…

III. ①矿产-南美洲②矿产资源开发-南美洲

IV. ①F477.061

中国版本图书馆 CIP 数据核字(2016)第 327115 号

南美洲地质矿产与矿业开发

陈玉明 等编著

责任编辑:王凤林 马 严

选题策划:毕克成 刘桂涛 张晓红

责任校对:张咏梅

出版发行:中国地质大学出版社(武汉市洪山区鲁磨路 388 号)

邮编:430074

电 话:(027)67883511

传 真:(027)67883580

E-mail:cbb@cug.edu.cn

经 销:全国新华书店

Http://cugp.cug.edu.cn

开本:880 毫米×1230 毫米 1/16

字数:911 千字 印张:28.75

版次:2018 年 7 月第 1 版

印次:2018 年 7 月第 1 次印刷

印刷:武汉中远印务有限公司

ISBN 978-7-5625-3968-1

定价:298.00 元

如有印装质量问题请与印刷厂联系调换

序一

南美洲是全球成矿规律研究的热点地区,也是全球矿产勘查投资的重点地区。区内石油、天然气、铜、金、银、铁、铝土矿、铅锌、锡、锂和铀等优势矿产在全球占有重要地位。欧、美、加、日、澳、韩等国家早已在此谋篇布局,竞相寻求将南美洲作为其全球资源配置战略安全的主要地区。

当前,我国正处于新型城镇化、工业化和农业现代化进程的关键期,是全球进口矿产品需求最大的国家。如何长期、安全和可持续地获取我国紧缺的矿产品已成为国家探索的前沿课题之一,也是制定国家经济社会发展战略的必要依据。南美洲资源禀赋较好,与我国互补性强,各国与我国双边关系互动良好。双方已在能源和矿产资源领域开展了卓有成效的合作,未来具有更好的合作前景。

中国地质调查局和中央地质勘查基金管理中心最近 10 多年来在南美洲开展了 20 余项国际地学合作研究,积累了丰富的地质矿产、矿业开发、矿业法律和投资环境等基础资料。这对我国开展国际合作,勘查开发南美洲矿产资源,全力支持国家能源资源安全保障具有重要的现实意义。作者在系统收集、整理和研究已有资料的基础上,结合在南美洲国际合作中获得的第一手研究成果,编写完成了本专著。

本专著系统地介绍了南美洲自然地理概况,区域地层、岩浆活动和构造演化;总结了区域能源和重要矿产资源特征,划分出三级成矿区带,概述了区域成矿作用与构造演化的关系,深化了对南美洲成矿规律的认识;梳理了各国矿产勘查与矿业开发现状,阐述了南美洲优势矿产资源的分布、成矿规律、典型矿床、勘查开发和资源远景;分析和对比了南美洲各国矿业开发状况和矿业投资环境,是第一部全面、系统论述南美洲地质、矿产和矿业开发的综合性著作。

本人热诚祝贺这部富有地域特色的《南美洲地质矿产与矿业开发》专著的出版。本专著无论对于政府制定全球资源配置战略还是矿业企业投资南美矿业,抑或专家学者开展南美地质矿产研究都具有重要的参考价值。同时向为国际地学交流合作作出突出贡献的作者表示由衷的敬意!

裴荣富

2017年12月22日

序二

在中国地质调查局发展研究中心组织编写《南美洲地质矿产与矿业开发》专著即将出版之际,本人有幸率先阅读这一鸿篇巨著,受益匪浅。

众所周知,南美洲成矿条件优越,矿产资源非常丰富,铜、铁、锰、铝、金、银、铅、锌、钴、锡、锑、钒、铋、铌、锂、钾盐及油气资源等,都在世界上占有非常重要地位,拉美的铜储量约占世界总储量的50%,仅在安第斯成矿带,已发现的、开采的和未发现的铜矿资源总量,可达 $13 \times 10^8 \text{t}$ 以上,显示出巨大的铜矿成矿与找矿潜力。南美地区又是世界上卤水锂资源最丰富的地区,约占世界卤水锂资源的67%,主要分布在普纳高原,构成了世界最大的卤水锂资源区,被称为世界“锂三角”地区。南美洲的优势矿产资源又多为我国短缺的重要战略资源。新世纪以来,随着我国经济建设与社会发展加速,能源与重要矿产资源的利用强度大幅攀升。石油、天然气、铀、铁矿石、铜、铝土矿、镍、铬铁矿、铅、锌、锡、钾盐等矿产的国内保障程度下降,对外依存度不断攀升。近10多年来,我国石油、铁矿石、铜、铝土矿、镍、铬铁矿、钾盐等的进口量,占世界贸易量的 $1/3 \sim 2/3$ 。我国铁矿石消费需求虽然已经到达高峰,但仍将保持高位。据预测,到2030年,我国大部分重要大宗矿产和能源资源,如铝、铅、锌、铜、镍、铬铁矿、钾盐、油气等,需求量将陆续到达消费高峰,然后在高位上运行。虽然近年来,我国步入调整经济结构、保持中高速发展的新常态,但是,由于南美洲的优势矿产资源与我国具有很强的互补性,能源和矿产资源一直是中拉经贸合作的最主要领域,这一态势在相当长的时期内仍将会持续发展。因此,我国地学界、矿业界及经济学界对南美洲地质矿产与矿业开发有着浓厚的兴趣,《南美洲地质矿产与矿业开发》专著的出版为大家提供了不可多得的参考文献。

该专著是自2003年以来,在中央“走出去”战略指引下,中国地质调查局启动境外地质矿产调查工作成果的一部分。中国地质调查局发展研究中心在南美地质调查工作的基础上,根据实际地质调查工作成果和收集的资料,组织从事南美地质矿产研究的部分人员编写此书。

综观全书,内容丰富,资料详实,颇具特色。该专著不仅介绍了南美洲自然地理、政治经济概况和成矿地质背景、成矿区带与成矿规律,并提供了一批重要的典型矿床,对南美洲矿产勘查与矿业开发的现状、找矿潜力和矿业投资环境进行了较全面的分析。该专著的出版不仅对从事境外矿业开发人员全面深入了解南美洲的地质矿产和矿业开发的现状与前景、促进中国与南美洲各国的矿业合作有重要价值,而且可供从事地质矿产、矿业开发和矿业经济研究者参考。开卷有益,特作此序。

姚书振

2016年9月7日于武汉

前 言

南美洲是拉丁美洲的主体,位于南半球西部,共有 12 个独立国家:哥伦比亚、委内瑞拉、圭亚那、苏里南、厄瓜多尔、秘鲁、玻利维亚、智利、阿根廷、巴拉圭、乌拉圭、巴西,还有法属圭亚那和马尔维纳斯群岛。南美洲各国正致力于推进经济结构调整和产业升级,处于发展的关键期。而中国已进入全面建成小康社会的决胜阶段,以创新、协调、绿色、开放、共享的发展理念为引领,正推动经济社会发展转型升级。国内外的学者认为,“快速发展的中国经济实力,正在快速转化成新型大国的外部影响力,一个成功的经济体是一种重要的吸引力来源”(Joseph,2006),“从而极大地密切了中国与地理上相距最远的拉丁美洲之间物质、信息、人际的联系”,“也促进了双方在心理上的迅速接近”(吴白乙,2015)。

在“走出去”战略和“两种资源、两个市场”的背景下,2003 年以来,中国地质调查局启动境外地质矿产调查国际合作工作。通过“地质矿产调查评价专项”“商务部援外资金”“国外矿产资源风险勘查资金”等渠道,依托国际合作平台,以资料收集、数据库建设、系列图件编制、地质-地球化学填图和航空物探等为技术手段,编制了安第斯等重要成矿区带基础地质矿产图件,分析研究重要成矿带成矿规律与资源潜力,调查评价重点地区资源潜力,建设全球矿产资源信息系统,为境外地质矿产工作提供信息服务。同时,在阿根廷、巴西和秘鲁等资源丰富国家的重点(典型)地区,以我国具有优势的地球化学方法和遥感地质为先导,开展综合地质调查,并取得了一系列研究成果,为政府决策提供了坚实的支撑,为企业和地勘单位“走出去”提供了形式多样的信息服务,与合作国建立了良好的合作关系,并取得了良好的合作调查研究成果。根据在南美洲从事多年地质调查和矿产勘查工作经验,我们对中南合作有切身体会。

1. 中南合作是双方的内在需求

进入 21 世纪,和平、发展、合作、共赢成为时代潮流。世界多极化和经济全球化成为各国谋求合作发展的大背景和总趋势。中国与南美洲国家虽然相距遥远,建交也比较晚(1970 年智利是第一个与中国建立外交关系的南美洲国家),但中国与南美洲各国共同的梦想和追求,双方在政治、经济、人文等领域的交流与合作发展迅速,实现了跨越式发展。尤其在经贸领域发展更快,中国已成为南美洲第二大贸易伙伴国和第三大投资来源国,南美洲则成为全球对华出口增速最快的地区。中南经济互补优势明显,南美洲国家资源丰富,发展条件得天独厚,中国长于技术、制造,市场广阔,资本积累丰富,双方合作前景广阔,潜力巨大。中国与南美洲国家加强互利合作,有利于推动各自经济社会的可持续发展,也有助于推动建立持久和平、共同繁荣的和谐世界,符合双方的共同利益。2015 年 1 月在北京举办了包括南美洲国家在内的中国-拉共体论坛首届部长级会议,会议发表了

《北京宣言》《中国与拉美和加勒比国家合作规划(2015—2019年)》《中拉论坛机制设置和运行规则》三大成果文件,双方将共同致力于政治上真诚互信、经贸上合作共赢、人文上互学互鉴、国际事务中密切协作、整体合作和双边关系相互促进的五位一体新格局,打造携手共进的人类命运共同体,中南合作是双方内在的需求。

2. 南美洲国家需要新型中南关系

20世纪80年代,南美洲国家普遍面临债务危机和经济困难。以美国为首的西方债权国借机向南美洲国家推行所谓的“华盛顿共识”。“华盛顿共识”发源于美国的新自由主义政治经济思潮,反对国家对经济的干预,主张完全市场化的自由市场经济,并以此所谓的“共识”为基本原则推行了南美洲国家市场经济改革,核心是缩减政府开支、企业减税、竞争性的汇率制度、金融和贸易自由化、减少政府干预、国企私有化和私有财产保护等。在实行这种改革的10年里,南美洲国家经济平均增长率仅为3%,远低于同期东亚地区发展中国家的6.5%~7.5%。导致南美洲国家宏观经济的脆弱性加大,国家产业竞争力和经济调控能力下降,因此这一阶段被称为“失去的十年”。在矿业领域,2003年成立国际矿业治理机构,所提出的“采掘业透明度倡议”,也体现着发达国家主导的新自由主义思想。对于发达国家的这些新自由主义包装,南美洲国家普遍都抵触。中国经济与西方不同的发展方式和近30年的快速发展,在南美洲国家产生了巨大影响,他们渴望与中国发展新型的中南合作关系,“拉美梦”与“中国梦”协同发展,积极应对经济发展的新挑战。

3. 矿产资源在中南合作中占重要地位

能源和矿产资源一直是中南经贸合作的最主要内容。新世纪以来,随着我国经济建设与社会发展加速,能源与重要矿产资源的利用强度大幅攀升。石油、天然气、铀、铁矿石、铜、铝土矿、镍、铬铁矿、铅、锌、锡、钾盐等矿产国内保障程度下降,对外依存度不断攀升。近10多年来,我国上述的能源和矿产资源的进口量约占世界贸易总量的1/3~2/3。随着我国钢铁、铜、铝、铅、锌等重要矿产品产能大幅增加,近年来国内产能过剩,有的甚至严重过剩。2014年,我国经济结构开始调整,步入了从高速增长到中高速发展的新常态,但对能源及矿产资源的刚性需求仍存在。我国铁矿石消费量虽然已经到达高峰,煤炭也接近峰值,但都仍将保持高位。据预测,到2030年,能源矿产和大部分重要大宗矿产,如石油、铝、铅、锌、铜、镍、铬铁矿、钾盐等,需求量将陆续到达消费高峰,并在高位上运行。

南美洲矿产资源丰富,与我国具有很强的资源互补性。南美洲的油气、铁、锰、铜、铝、铅、锌、钴、锡、锑、钒、铋、铌、锂、金、银、钾盐等在世界上占有非常重要地位,其中多为我国短缺的重要战略资源。南美洲的铜储量约占世界总储量的50%,仅在安第斯成矿区,已发现的、开采的和未发现的铜矿资源总量可达 13×10^8 t以上,显示出巨大的铜矿找矿潜力。南美洲是世界上卤水锂资源最丰富的地区,约占世界卤水锂资源的67%,主要分布在普纳高原,被称为世界“锂三角”地区。矿产品贸易在我国与南美洲国家贸易中占有重要地位。

4. “两洋铁路”建设展现中南合作良好远景

“两洋铁路”,即横跨南美洲大陆的巴西和秘鲁,连接太平洋和大西洋两岸的铁路建设

项目是中国与巴西、秘鲁的重要合作项目,既能带动当地经济发展,提升基础设施水平,又将为加强双边矿产资源合作提供良好远景。“两洋铁路”经过南美洲的重要成矿区带:以铁、锰、铝土矿、云母及多种稀有金属为主的巴西高原和圭亚那高原;主要产有色金属、石油、硝石和硫磺的安第斯山区;赤道至 35°S 之间多种有色金属矿产成矿带;从秘鲁南部至智利中部世界最大的斑岩型铜矿带;玻利维亚境内储量仅次于东南亚的东科迪勒拉锡矿带,其中铅、锌、铋、钼、银、锑等也非常丰富,仅秘鲁的铋矿储量就居世界第二位。“两洋铁路”穿过的盆地和平原区,矿产资源也很丰富。石油主要分布在安第斯山北段的山间构造谷地或盆地中,奥里诺科平原东部和亚马孙平原西部的石油也较重要,中部平原矿产资源以沉积型矿产为主。这些矿产的开发受交通条件的制约,“两洋铁路”的规划和建设对沿线大宗矿产的开发利用是极大利好。

5. 介入南美洲矿业的最好时机已经出现

矿产资源分布的不均性,决定了世界任何国家都无法完全依赖本国的矿产资源实现自身的经济发展,都需要进行全球资源优化配置。21世纪初我国经济的高速增长,带动了世界经济的快速发展和矿产品价格的快速上升。这场“矿业盛宴”持续了10年,全球矿产资源消费快速增长,资源勘查持续繁荣。从2008年开始,全球金融危机导致全球经济危机,全球矿业也进入了调整—衰退期。

在国际、国内的大背景下,全球矿产品价格大幅度下跌,主要资本市场矿业股股价下跌,初级勘查公司市值大幅缩水、融资困难,跨国矿业公司也面临资金紧张,矿业公司不景气状况继续蔓延。全球矿业市场目前正处于多年不遇的收购良机,这为我国企业“走出去”勘查、开发矿产资源提供了难得的机遇。历史经验表明,矿业高潮泡沫最大的时候往往是圈套,而能抓住矿业低谷介入,提前布局,就能把握住历史性机遇。

为使我国从事境外矿产资源勘查开发企业对南美洲的地质矿产和矿业开发有系统的了解,促进中国与南美洲各国的矿业合作,中国地质调查局发展研究中心在南美地质调查工作的基础上,根据国际合作成果和收集的资料编写了本书。

本书共14章。第一章南美洲的基本情况,包括自然地理、人文地理、政经简况、南美洲国家与中国的关系、优势资源及其与中国的互补性、中国企业在南美洲矿业开发中的现状等。第二章区域地质,包括地层、岩浆活动、构造及其演化。第三章矿产资源,包括矿产资源分布特征、成矿区带划分,并论述了成矿地质特征、成矿时空演化。第四章矿产勘查与矿业开发,从南美洲各国的地质工作程度、矿产勘查、矿业开发和主要矿业公司等方面,介绍南美洲矿业勘查和矿业开发的状况。从第五章到第十三章,分别介绍了南美洲的石油、天然气、铜、金、银、铅、锌、锡、铁、锂、铀、铝土矿等重要能源和矿产资源的地质和成矿规律、典型矿床、勘探开发和资源远景。第十四章矿业投资环境,重点介绍南美洲各国的矿业管理机构和管理,详细介绍了矿业权设置和管理办法、矿业法律、矿业税收和矿业投资环境分析,并评述其对矿产勘探、矿业开发和矿业经济的影响。

本书由中国地质调查局发展研究中心境外地质矿产研究部组织编写,具体分工如下:前言,陈玉明;第一章,陈玉明、陈秀法;第二章,张潮、陈玉明、赵宏军;第三章,张潮、陈玉明;第四章,陈秀法、陈玉明;第五章,吴林强;第六章,张潮、陈玉明、元春华;第七章,崔敏

利;第八章,张伟波;第九章,陈喜峰;第十章,赵宏军;第十一章,王秋舒;第十二章,陈秀法;第十三章,陈喜峰;第十四章,陈玉明、陈喜峰。最后由陈玉明和张潮统稿。

致谢

本书是“海上丝绸之路重点地区有色金属资源潜力评价(项目编号:DD20160118)”“中阿合作阿根廷地球化学填图与资源潜力分析(项目编号:12120115068401)”“南美巨型成矿带重要矿床地质背景、成矿作用和找矿潜力研究项目(项目编号:12120114092901)”和“中阿合作阿根廷西北部地区1:25万地球化学调查(阿根廷西北部地区铜(金)矿资源潜力调查与评价)(项目编号:10262A002,201210A06200202)”项目的主要研究成果。中国地质调查局和发展研究中心的严光生、徐勇、蔡纲、施俊法、向运川、刘大文和叶锦华等对本书的编写给予了极大的关注和指导,裴荣富院士和姚书振教授为本书作序,吴传璧、邱瑞照、卢民杰、项仁杰、戴自希、宋国明、王淑玲、高光明、肖庆辉等专家多次审阅本书,并修改文稿或给出修改意见。郑榆林、张超、王橹玺等协助清绘了部分图件并协助查阅了部分文献。不同专家编写了南美洲国家和地区的国别报告并提供了详细的参考资料:巴西和乌拉圭,王靓靓;阿根廷和哥伦比亚,陈玉明;智利、苏里南和玻利维亚,赵宏军;秘鲁和厄瓜多尔,陈秀法和高光明;委内瑞拉,陈玉明和元春华;巴拉圭和法属圭亚那(地区),张伟波;圭亚那,程志中。由于篇幅所限,本书没有收入南美洲的国别报告。本书的出版是各位作者和专家共同努力的结果。由于资料来源的多元性和作者的水平所限,不足之处敬请读者指正。

Foreword

South America, the main part of Latin America, lies in the western part of the southern hemisphere. There are 12 independent countries: Colombia, Venezuela, Guyana, Suriname, Ecuador, Peru, Bolivia, Chile, Argentina, Paraguay, Uruguay, Brazil, French Guiana and the Malvinas Islands. All countries in South America are working hard to promote economic restructuring and industrial upgrading in the current crucial period of development, while China has entered the decisive phase of building a well-off society in an all-round way, being guided by the development concept of innovation, coordination, greenness, openness and sharing and pushing forward the transformation and upgrading of economic and social development. Scholars both at home and abroad think that “the rapidly developing economy of China is rapidly transforming into an external influence of a new powerhouse. And a successful economy is an important source of attraction” (Joseph, 2006). “This greatly enhances the physical, information and interpersonal relations between China and South America that are geographically far apart” and “promoted the rapid psychological closeness of both parties” (Wu Baiyi, 2015).

Under the strategy of “Going Global” and against the backdrop of “Two Resources and Two Markets”, since 2003, the China Geological Survey (CGS) started the investigation of overseas geology and mineral resources. Through the funding channels of “Special Fund for Geological and Mineral Investigation and Evaluation”, “Aid Fund by Ministry of Commerce”, “Foreign Mineral Resources Risk Exploration Funds” and relying on the international cooperation platform, CGS compiles basic geologic mineral maps in important metallogenic belts such as Andes orogen, analyzes and studies metallogenic regularity and resource potentials of important metallogenic belts, investigates and assesses resource potentials in key areas, constructs a global information system for mineral resources and provide information services for overseas geology and mineral work by technical means of data collection, database construction, series map making, geo-geochemical mapping and aero-geophysical prospecting. At the same time, in the key (typical) regions of multipresource-rich countries, CGS uses the advantageous geochemical methods and remote sensing geology of our country as the guide to conduct comprehensive geological surveys and obtain a series of research results, which provided solid support for government decision-making and providing a variety of information services for enterprises and geological survey units to “Go Out”. CGS has established good relationships of cooperation with the

partner countries in South America. Good results are achieved. Based on geological survey and mineral exploration experience in South America, we have summarized the following best practices of Sino – South America cooperation.

1. Sino – South America Cooperation: An Inherent Demand of Both Sides

In the 21st century, peace, development, cooperation and win – win solutions have become the trends of the times. In the increasingly multi – polar world and globalized economy, all countries have been seeking cooperative development. Although China and South American countries are far apart and the establishment of diplomatic relations is relatively late (in 1970, Chile was the first South American country to establish diplomatic relations with China), China and South American countries all have their common dreams and aspirations. Both sides have made rapid political, economic and cultural exchange and cooperation and achieved leapfrog developments together. In particular, China has become the second largest trading partner and the third largest source of investment in South America, while South America has grown to the fastest – growing region in the world in terms of exports to China. China and South America are obviously complementary in economy. South American countries are rich in resources and have naturally favorable conditions for development. China excels at technology, manufacturing, vast market and rich capital accumulation. The cooperation prospects of the two sides are bright and have great potentials. Strengthening mutually beneficial cooperation between China and South American countries is conducive to promoting the sustainable social and economic development of both sides as well as contributing to the establishment of a harmonious world of lasting peace and common prosperity, which is in the common interests of both sides. In January 2015, the first ministerial meeting of China – Latin American Community Forum was held in Beijing, convening the South American countries. The three major outcome documents of *the Beijing Declaration on the First Ministerial Meeting of China – Latin America Forum*, *The Cooperation Plan between China and the South American and Caribbean Countries (2015 – 2019)* and *the Establishment and Operational Rules for China – Latin America Forum Mechanism* were promulgated. Both sides will work together to have sincerity and mutual trust in politics and win – win cooperation in economy and trade, learn from each other culturally and work closely together in international affairs and promote the overall cooperation and bilateral relations in this five – in – one new pattern of cooperation, fostering a community of going forward hand in hand. Sino – South America cooperation is an inherent demand of both sides.

2. South American Countries Need A New Type of Sino – South America Relationship

In the 1980s, the majority of South American countries faced the debt crisis and economic difficulties. The U. S. – led western creditors took the opportunity to promote the so – called Washington Consensus to South American countries. The Washington Consensus originated in the neo – liberal political and economic trends of the United States, opposing the state’s intervention in the economy and advocating a fully free – market economy.

The core of the market economy reform in South American countries, which is based on this consensus, is less government expenditures, less corporate tax cuts, a competitive exchange rate system, financial and trade liberalization, less government intervention, privatization of state – owned enterprises and protection of private property. In the 10 years since this reform was implemented, the average rate of economic growth in South American countries was only 3%, well below the 6.5%~7.5% of the developing countries in East Asia at the same period. This period was called “the Lost Decade” of South America for its vulnerable macroeconomic growth and declining national industrial competitiveness and economic control of the South American countries. In the field of mining, an international mining agency, established in 2003 launched the “Extractive Industries Transparency Initiative”, also embodying the neo – liberal ideas dominated by developed countries. This initiative representing the neo – liberal mentality was promoted by developed countries and generally aroused resentment among South American countries. The different modes of development of the Chinese economy and the West as well as the rapid development of China in the past 30 years have had a tremendous impact on the countries of South America. They dying to develop a new type of Sino – South America cooperation with China. The coordinated development of “South American Dream” and “Chinese Dream” should actively work together to rise to new challenges of economic development.

3. Construction of “Two Oceans by Railroad” Shows Good Prospects of Sino – South America Cooperation

The “Two Oceans by Railroad” connects Brazil and Peru across the continent of South America. The railroad construction project linking the Pacific Ocean to the Atlantic Ocean is an important cooperation project between China and Brazil and Peru. It can boost the local economic development and upgrade the infrastructure level, as well as provide good prospects for strengthening bilateral cooperation in mineral resources. The Railroad passes through important metallogenic belts in South America: the Brazilian Plateau and the Guyana Plateau rich in iron, manganese, bauxite, mica and various rare metals, the Andes mainly producing nonferrous metals, petroleum, saltpeter and sulfur, a variety of non – ferrous metal mineralization belts between the equator and the 35° latitude and the world’s largest porphyry copper belt stretching from southern Peru to central Chile; Bolivia’s mine reserves are second to the eastern Cordilleratin ore belt in Southeast Asia. South America is also rich in lead, zinc, bismuth, molybdenum, silver, antimony, etc. and just the bismuth ore reserves in Peru rank second in the world. The basin and plains crossed by the “Two Oceans by Railroad” also have abundant mineral resources. Oil is mainly distributed in mountainous tectonic valleys or basins in the northern section of the Andes, and oil is also important in eastern Orinoco plain and western Amazonian plains. In Central Plains, resources are mainly sedimentary minerals. The development of these minerals is constrained by the traffic conditions. The planning and construction of the “Two Oceans by Railroad” are extremely favorable to the development and utilization of

the bulk mineral resources along the line.

4. Mineral Resources Play An Important Role in Sino – South America Cooperation

Energy and mineral resources have always been the most important part of Sino – South America economic and trade cooperation. Entering into the new century, with the acceleration of economic construction and social development in our country, energy and important mineral resources have been being utilized more intensely. Our mineral resources such as oil, natural gas, uranium, iron ore, copper, bauxite, nickel, chromite, lead, zinc, tin and potash have been decreasing, and the dependence on foreign countries keeps rising. In the past 10 years, China’s import of energy and mineral resources above – mentioned account for 1/3~2/3 of world trade. Even so, with the substantial increase in the production capacity of China’s major minerals such as iron and steel, copper, aluminum, lead and zinc, overcapacity prevailed in China in recent years and is even very serious for some minerals. In 2014, China’s economic restructuring entered a new normal of medium – to – high growth from a period of rapid development but there is still a rigid demand for energy and mineral resources. Although China’s iron ore consumption has reached its peak and that of coal is also approaching its peak, but both will remain high. It is predicted that by 2030, the demand for energy and most major bulk minerals such as oil, aluminum, lead, zinc, copper, nickel, chromite and potash will all reach the peak of consumption and will run at a high level.

South America is rich in mineral resources and is quite complementary with China. The oil and gas, iron, manganese, copper, aluminum, lead, zinc, tin, antimony, vanadium, bismuth, gold, silver and potassium salt occupy a very important place in the world, most of which are important strategic but insufficient resources for our country. Copper deposits in South America account for about 50% of the world’s total reserves. The total amount of copper resources discovered, exploited and undiscovered only in the Andean metallogenic belt, is more than 13×10^8 t, indicating huge copper prospecting potentials. South America have the world’s most abundant lithium brine resources, accounting for about 67% of the world’s total, mainly distributed in the Puna Plateau, known as the world’s lithium triangle. The mineral trade occupies an important position in the trade between our country and South American countries.

5. South America is a Hot Area of Mining Development Worldwide at Present

The uneven distribution of mineral resources determines that any country in the world is not able to be fully self – sufficient in mineral resources to achieve its own economic development. All countries need to rely on the optimization of global resources allocation. The rapid economic growth of our country in the early 21st century drove the rapid development of the world economy and the rapid opening of the prices of mineral products. This “mining feast” lasted 10 years, witnessing the rapid growth of global consumption of mineral resources and on – going booming resource exploration. Starting from 2008, the global financial crisis led to the global economic crisis, making the global min-

ing industry also enter a period of adjustment – recession.

Against the international and domestic backdrop, the prices of global mining products dropped drastically. The stock prices of mining stocks in major capital markets plunged. The market capitalization of primary exploration companies shrunk dramatically and financing difficulties were encountered. Multinational mining companies also faced financial constraints. The downturn of mining companies continued. There is a rare opportunity in years in the global mining market in terms of acquisition. The market remains low, which provides good opportunities for mining enterprises to enter the “going global” prospecting and mineral resources development. Historical experience shows that the biggest bubbles are often hidden in the mining boom, and those that can seize the mining lows for intervention and plan in advance, can seize the historic opportunity.

To promote mining cooperation between China and all South American countries, Development Research Center (DRC) of CGS compiled this book on the results of the actual geological survey and collected information.

The book consists of 14 chapters. Chapter 1 introduces the basic situation of South America, including natural geography, political economy, the relations between South American countries and China, superior resources of South America and their complementarity with China. Chapter 2 presents an overview of regional geology in South America, including stratigraphy, magmatism, tectonic unit division, features of major tectonic units, and tectonic evolution. Chapter 3 focuses on the mineral resources in South America, including the distribution of mineral resources, metallogenic belt division, and discusses the geological characteristics of mineralization and temporal and spatial evolution of mineralization. Chapter 4 is a briefing on mineral exploration and mining development in South America from the aspects of geological work, mineral exploration, mining development and major mining companies in South America. The focus is the role played by Chinese enterprises on exploration of mineral resources in South America. From Chapter 5 to Chapter 13, we introduce the geological and metallogenic regularity, typical deposits, exploration and development of resources and vision of the key mineral resources of South America such as oil, natural gas, copper, gold, silver, iron, bauxite, lead, zinc, tin, lithium and uranium. Chapter 14 is on the mining investment environment, focusing on the mining management agencies and management of countries in South America, detailing the mining rights and management practices, mining law, mining tax and mining investment environment analysis, and commenting on its impact on mineral exploration and mining development and mining economy.

This book is compiled by the Overseas Geology and Mineral Resources Research Department of DRC, CGS. The specific division of work is as follows: Preface by Chen Yuming; Chapter 1 by Chen Yuming and Chen Xiufa; Chapter 2 by Zhang Chao, Chen Yuming and Zhao Hongjun; Chapter 3 by Zhang Chao and Chen Yuming; Chapter 4 by Chen Xiufa and Chen Yuming; Chapter 5 by Wu Linqiang; Chapter 6 by Zhang Chao,

Chen Yuming and Yuan Chunhua; Chapter 7 by Cui Minli; Chapter 8 by Zhang Weibo; Chapter 9 by Chen Xifeng; Chapter 10 by Zhao Hongjun ; Chapter 11 by Wang Qiushu; Chapter 12 by Chen Xiufa; Chapter 13 by Chen Xifeng; Chapter 14 by Chen Yuming and Chen Xifeng. Finally Chen Yuming and Zhang Chao unified the draft.

Acknowledgments

This book represents main research results of *Potential Evaluation of Non-ferrous Metal Resources in Key Areas of Maritime Silk Road* (Project Number: D20160118), *Sino-Argentina Cooperation on Geochemical Mapping and Resource Potential Analysis of Argentina* (Project Number: 12120115068401), *Research on Geological Background, Mineralization and Prospecting Potential of Important Mineral Deposits in South America* (Project Number: 12120114092901) and *Sino-Argentina Cooperation on 1:250,000 Geochemical Survey in Northwestern Argentina (Potential Survey and Evaluation of Copper (Gold) Resources in Northwest Argentina)* (Project Number: 10262A002, 201210A06200202). Yan Guangsheng, Xu Yong, Cai Gang, Shi Junfa, Xiang Yunchuan, Liu Dawen, Ye Jinhua and other leader from CGS and DRC of CGS gave great attention and guidance to the compiling of the book. Pei Rongfu, a famous academician, and Yao Shuzhen, Editor-in-chief, wrote the book preface and Wu Chuanbi, Qiu Ruizhao, Lu Minjie, Xiang Renjie, Dai Zixi, Song Guoming, Wang Shuling, Gao Guangming, Xiao Qinghui and other experts reviewed the book several times and revised the manuscript or gave comments on how to revise. Zheng Yulin, Zhang Chao, Wang Luxi, etc. helped fair draw some of the maps and check out some documents. Different experts prepared country reports for South American countries and provided detailed references: Brazil and Uruguay by Wang Liangliang; Argentina and Colombia by Chen Yuming; Chile, Surinam and Bolivia by Zhao Hongjun; Peru and Ecuador by Chen Xiufa and Gao Guangming; Venezuela by Chen Yuming and Yuan Chunhua; Paraguay and French Guyana (region) by Zhang Weibo; Guyana, Cheng Zhizhong. Due to space constraints, this book does not have a overall report on South America. The merits of the book are the joint efforts of all the authors and experts. Because of the diverse sources and the limitations of the author, readers can feel free to correct the inadequacies.

目 录

第一章 南美洲概况与中南关系	(1)
第一节 自然地理	(1)
第二节 人文地理	(12)
第三节 政经简况	(14)
第四节 中南关系和矿业开发	(17)
第二章 区域地质	(26)
第一节 地 层	(27)
第二节 岩浆活动	(42)
第三节 构造及其演化	(48)
第三章 矿产资源	(67)
第一节 分布特征	(67)
第二节 成矿区带划分	(70)
第三节 成矿区带地质特征	(72)
第四章 矿产勘查与矿业开发	(94)
第一节 地质工作程度	(94)
第二节 矿产勘查	(102)
第三节 矿业开发	(109)
第四节 矿业公司	(111)
第五章 石油、天然气	(117)
第一节 资源概述	(117)
第二节 成藏规律	(120)
第三节 典型含油气盆地	(124)
第四节 勘探开发	(135)
第五节 远景区分析	(141)
第六章 铜 矿	(156)
第一节 资源概述	(156)
第二节 成矿规律	(157)

第三节	典型矿床	.....	(169)
第四节	勘查开发	.....	(182)
第五节	远景区分析	.....	(200)
第七章	金、银矿	.....	(207)
第一节	资源概述	.....	(207)
第二节	成矿规律	.....	(209)
第三节	典型矿床	.....	(213)
第四节	勘查开发	.....	(223)
第五节	远景区分析	.....	(225)
第八章	铅、锌矿	.....	(229)
第一节	资源概述	.....	(229)
第二节	成矿规律	.....	(230)
第三节	典型矿床	.....	(237)
第四节	勘查开发	.....	(250)
第五节	远景区分析	.....	(254)
第九章	锡 矿	.....	(258)
第一节	资源概述	.....	(258)
第二节	成矿规律	.....	(259)
第三节	典型矿床	.....	(261)
第四节	勘查开发	.....	(268)
第五节	远景区分析	.....	(271)
第十章	铁 矿	.....	(274)
第一节	资源概述	.....	(274)
第二节	成矿规律	.....	(275)
第三节	典型矿床	.....	(283)
第四节	勘查开发	.....	(293)
第五节	远景区分析	.....	(310)
第十一章	锂 矿	.....	(316)
第一节	资源概述	.....	(316)
第二节	成矿规律	.....	(318)
第三节	典型矿床	.....	(320)
第四节	勘查开发	.....	(324)
第五节	远景区分析	.....	(334)
第十二章	铀 矿	.....	(338)
第一节	资源概述	.....	(338)