

高瑞祺 赵政璋 主编

中国油气新区勘探

**THE FRONTIER
PETROLEUM
EXPLORATION
IN CHINA**

· 第三卷 ·

渤海湾盆地隐蔽油气藏勘探

石油工业出版社
Petroleum Industry Press

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The Frontier Petroleum Exploration in China

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Gao Ruiqi Zhao Zhengzhang

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渤海湾盆地隐蔽油气藏勘探

Exploration of Subtle Oil and Gas Reservoirs in Bohai Bay Basin

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内 容 提 要

本书是《中国油气新区勘探》丛书之卷三。

本书着重论述了渤海湾盆地复杂隐蔽油气藏的形成和分布,与裂谷多期伸展和断陷转移形成不同层序叠复的富油气凹陷的理论研究进展,并对油气藏进行了分类,划分为复杂隐蔽断裂构造油气藏与地层—岩性油气藏两大类型,进而提出了勘探潜力预测的方向、方法。

书中探讨了地球物理勘探方法研究在复杂断块油气藏中的重要作用,岩浆岩储层油藏的地震预测法、砂砾岩体的地球物理测井资料特征、反射特征以及预测方法和技术。这些都反映了综合的地质研究与先进的工程技术相结合是渤海湾地区近些年来获得成就的根本保证,也是极其宝贵的经验。

本书可作为油气勘探开发相关专业人员的重要参考资料以及专业院校师生的重要课外读物。

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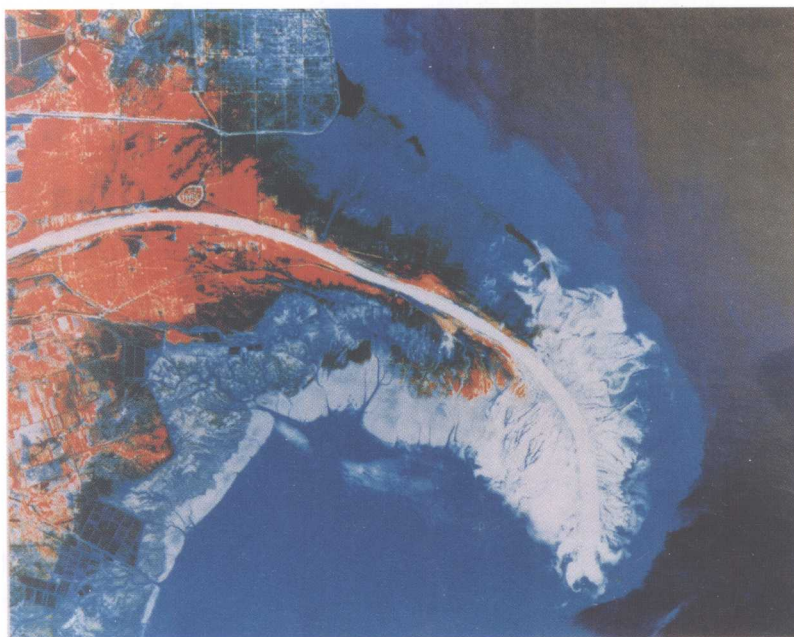
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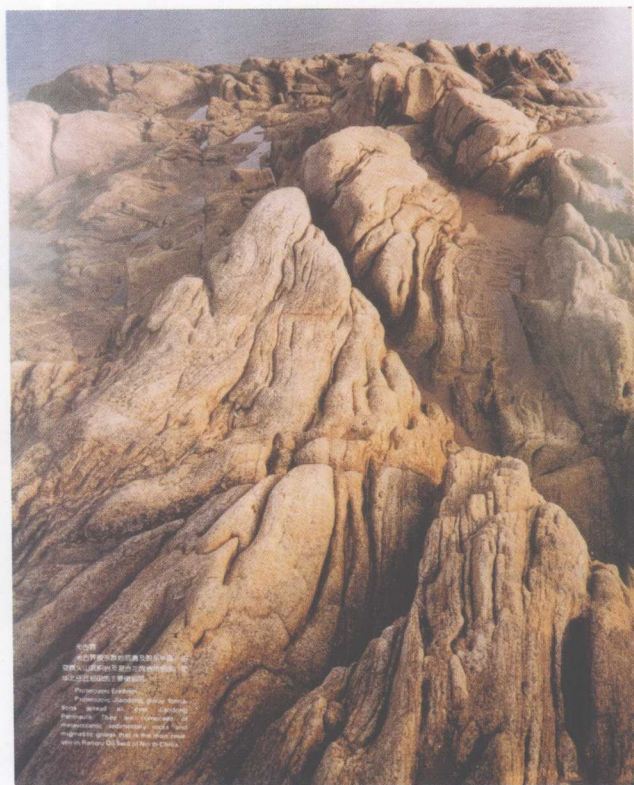
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1998年大港千米桥潜山板深7井喜获高产油气流



奥陶系露头(大港千米桥、胜利桩西等潜山油气田储层)



元古宙露头(辽河静安堡、胜利王庄等潜山油气田储层)



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中国的油气勘探在经历了 50 年代的初创阶段后,从 60 年代起实施勘探战略东移,在松辽和渤海湾等盆地陆续发现并开发了一批大中型油田,到 1978 年原油产量突破亿吨大关。从“七五”开始(1986 年),石油勘探难度增大,“八五”、“七五”与“六五”相比,新发现的储量增长保持在一个较稳定的水平,但新发现的储量单元数成倍增加,储量单元规模成倍减少,从而陆上原油产量只能呈缓慢增长态势,到 2000 年,全国年产油量为 1.63 亿吨。与此同时,我国天然气勘探在“八五”和“九五”期间获得重大发展,“八五”获得的天然气储量相当于前 40 年的总和,“九五”获得的天然气储量是“八五”的两倍,2000 年获得的天然气储量超过 8500 亿立方米,为我国天然气工业的快速发展奠定了一定的基础。

回顾近十多年的油气勘探历程,新地区、新领域、新层系的勘探起了十分重要的作用。陆上西部石油勘探的加快,改变了东西部后备储量增长的结构,每年石油探明加控制储量增长的比例接近 1:1。随着天然气勘探的重视和加强,西部四大天然气富集区的格局已经形成,整装储量规模在 2000 亿立方米以上的气田已经发现两个。总之,陆上油气新区勘探的显著成果,充分展现了我国石油工业资源的潜力。

为了系统总结我国油气勘探成果和油气分布规律,分析预测有利含油地区,做出正确的勘探部署,我国的石油地质学家出版了一大批石油地质领域各专业的专著和各油气田的系列学术丛书,为发展石油地质学和油气勘探工作做出了重要贡献。其中从 1983 年到 2001 年期间的 18 年,可以说有三部 27 卷学术著作,对中国油气勘探成果进行了不同侧重点的总结。1983 年至 1994 年,由翟光明主编的 16 卷《中国石油地质志》,应用了建国后大量的实际油气勘探资料,进行综合石油地质理论和油气分布规律研究,是一套全面、系统的中国石油地质著作。1997 年至 1999 年,由邱中建、龚再升主编的四卷《中国油气勘探》,是一部对中国半个世纪大陆和海上油气勘探的经验总结,从中国油气复杂的地质背景出发,力求客观地、历史地分析 100 多个油气田实例,使读者了解到,中国油气勘探历程的艰难曲折,成绩的丰硕巨大。从 2000 年至 2001 年,由高瑞祺、赵政璋主编的七卷《中国油气新区勘探》,总结了近十多年来我国陆上油气勘探在新地区、新领域、新层系所获得的丰硕成果,及石油地质理论和认识的发展,依据勘探科技工程的概念,在认识勘探对象和评价勘探目标时,力求做到地质综合研究与工程技术进步的结合。实践证明,在陆上油气勘探中每一次大的突破都是二者密切配合的结果。因此,针对勘探目标展开的地质综合研究和依托勘探工程进行的工程技术攻关的有力配合,是降低勘探风险,提高勘探效益,获得重大突破的关键。

《中国油气新区勘探》是原中国石油天然气总公司“九五”设立的七大勘探科技工程攻关成果的系统总结,分为七卷,分别是:《塔里木盆地库车坳陷大气田勘探》、《中国陆上天然气勘探新领域》、《渤海湾盆地隐蔽油气藏勘探》、《中国西北地区侏罗系油气分布》、《中国南方海相油气地质及勘探前景》、《青藏高原石油地质》和《中国煤层气勘探》。这套丛书不仅仅是概述了 1993 年成立的新区勘探事业部和陆上各油气田油气新区勘探实践和成果,同时还对近十多年来我国在油气新区、新领域、新层系勘探过程中,从事的大量综合地质研究所获得的认识和大规模技术攻关所取得的成果作了深入的剖析,重要的是对未来勘探前景作了客观的分析和评

价。我作为一名老石油工作者,非常希望这些重要的认识、技术和评价对今后陆上新区油气勘探能有所帮助。

《中国油气新区勘探》的出版,对丰富我国石油地质理论、发展石油勘探技术、提高油气勘探水平,将会做出新的贡献,希望它能在加速我国陆上油气新区勘探的发展,实现新区勘探的更多突破发挥应有的作用。

2001年
2月12日

First Preface

China's oil and gas exploration focus started to shift eastward from the 1960s after the country conducted oil and gas exploration for half a century. A number of large and medium-size oil fields have been discovered and put into development in Songliao basin and Bohai Bay basin. The crude oil production topped 100 million tons in 1978. Starting from the Seventh Five-Year Plan (1986), oil exploration became more and more difficult. As compared with the Sixth Five-Year Plan, the reserves growth was kept at a stable level during the periods of Seventh Five-Year Plan and Eighth Five-Year Plan. However, the amount of newly discovered reserves units increased while the scale of the reserves decreased. The growth of crude production slowed down in China. As of 2000, the country's annual production reached 163 million tons. Meanwhile, great progress has been made in the country's natural gas exploration in the past decade. The additional natural gas reserves during the Eighth Five-Year Plan period amounted to the total reserves discovered in the previous four decades. The additional natural gas reserves discovered in the Ninth Five-Year Plan period are twice as high as those in the Eighth Five-Year Plan period. The natural gas reserves exceeded 850 billion cubic meters in 2000, laying a solid foundation for the country's rapid natural gas industrial development.

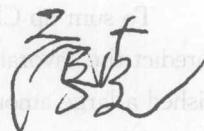
Reviewing the oil and gas exploration process in the past decade, exploration of new areas, new fields and new strata has played an important part. Acceleration of onshore oil exploration in the western part of the country has changed the structure of the standby reserves in the eastern and western parts. The proportion of proven and controlled oil reserves approaches 1:1 each year. With the efforts strengthened for natural gas exploration, four major natural gas abundance zones have taken shape in the western region. Two natural gas fields have been discovered there with the reserves scale exceeding 200 billion cubic meters. Generally speaking, remarkable achievements have been made in onshore oil and gas exploration of new areas, indicating the resources potential for the country's oil industrial development.

To sum up China's oil and gas exploration results and the distribution law and analyze and predict the favorable oil areas for exploration deployment, the Chinese oil geologists have published a large amount of writings and academic serials, thus making great contribution to oil geological development and oil and gas exploration work. A total of 27 volumes in three parts have been published in a period of 18 years from 1983 to 2001 to summarize China's oil and gas exploration results. Zhai Guangming was responsible of compilation of the 16-volume *Petroleum Geology of China* from 1983 to 1994. The series of books has used a large quantity of actual oil gas exploration data to make an integrated study of oil geological theory and oil and gas distribution law. It is a complete and systematic series of works on China's petroleum geology. Qiu Zhongjian and Gong Zaisheng were responsible for compilation of the 4-volume *Petroleum Exploration in China* from 1997 to 1999. The series of books, based on the country's complicated oil and gas geological

background, summarizes onshore and offshore oil and gas exploration experience in China in half a century and take more than 100 oil and gas fields as examples for analysis. Readers can learn about China's difficult oil and gas exploration process and remarkable results in this field. From 2000 to 2001, Gao Ruiqi and Zhao Zhengzhang were responsible for compilation of the seven-volume *The Frontier Petroleum Exploration in China* that has summed up the rich results China has achieved in onshore oil and gas exploration in new areas, new fields and new strata. The serial also focus on petroleum geological theoretical development and combination of integrated geological research with engineering technical progress for assessment of exploration targets. The onshore oil and gas exploration breakthroughs have indicated that combination of integrated geological research with exploration engineering technical progress holds the key to reduction of exploration risk and improvement of exploration efficiency.

The Frontier Petroleum Exploration in China, which systematically sums up exploration results achieved by CNPC during the Ninth Five-Year Plan period, covers *Exploration of the Large Gas Field in Kuche Depression of Tarim Basin*, *New Areas for Onshore Natural Gas Exploration in China*, *Exploration of Subtle Oil and Gas Reservoirs in Bohai Bay Basin*, *Jurassic Oil and Gas Distribution in Northwest China*, *Marine Oil and Gas Geology and Exploration Prospect in South China*, *Petroleum Geology of Qinghai-Tibet Plateau*, and *China's Coalbed Methane Exploration*. This book not only outlines the exploration work and results achieved in the new areas by the New Area Exploration Department, founded in 1993, and various oil and gas fields but also analyze the process of oil and gas exploration conducted in the new areas, new fields and new stratum series in the recent decade in China. It also makes objective analysis and evaluation of the prospect for future exploration. As an old petroleum worker, I hope those important knowledge, technology and evaluation may be helpful to future onshore oil and gas exploration in the new areas.

Publication of *The Frontier Petroleum Exploration in China* will make contributions to enriching China's petroleum geological theory, developing petroleum exploration technology and raising the oil and gas exploration level. I hope that this book is helpful to acceleration of China's onshore oil and gas exploration in the new areas and realization of more exploration breakthroughs in the new areas.



Tang Ke
May 23, 2001

序 二

新中国成立后,经过全国石油职工 20 多年的艰苦努力,我国油气勘探取得了巨大成就,到 1978 年原油产量突破亿吨大关。随后,原油产量达到 1.6 亿吨以上,居世界第 5 位。但是,从“七五”计划开始,我国陆上原油产量呈明显缓慢增长态势,近几年每年需要进口相当数量的石油。形成这种局面的根本原因是后备储量不足。为了保证我国油气工业可持续发展,必须扩大勘探领域,增加后备储量。加强新区、新领域的勘探,必然会向边远、深层、复杂和隐蔽目标延伸,而且地形复杂,施工条件差,只有配合相应的先进的科技工程攻关,方可降低风险,提高勘探效果。因此,加大勘探力度,扩大勘探领域,找寻大中型油气田,迅速增加后备储量,是实现石油工业可持续发展的根本保证。

“九五”期间,中国石油天然气集团公司根据勘探形势发展,及时地组织了“塔里木盆地库车坳陷前山带复杂构造勘探”、“中国陆上天然气勘探新领域”、“中国东部深层石油地质综合评价及目标选择”和“中国北方侏罗系石油地质综合研究及勘探目标选择”等七个科技工程攻关项目。近几年,油气新区、新领域勘探的效果明显地显现出来,如库车坳陷克拉 2 和陕北苏里格大气田的发现和渤海湾深层的新突破等。

《中国油气新区勘探》概括地对七项科技工程攻关成果进行了分析总结,其中概述了近十年来我国在油气新区、新领域、新层系的勘探成果。这些研究内容包括了大量的石油地质资料分析,及对基本石油地质理论、成藏机理和成藏系统的研究,其成果丰富了我国油气地质理论基础。与此同时,在物探、钻井、测试等科技攻关中也取得新的进展,获得了显著效果。

“九五”期间,全国油气勘探成果十分显著,这是油气新区勘探中的科技工程攻关与石油地质理论研究密切结合的产物,是近几年取得重要油气突破的关键所在。在《塔里木盆地库车坳陷大气田勘探》卷中,总结了克拉 2 大气田勘探,关键是攻克了高陡复杂构造带的山地地震技术和钻井技术两大难关,同时加强地质综合研究并且大胆决策起到重要作用。其他如《中国陆上天然气勘探新领域》、《渤海湾盆地隐蔽油气藏勘探》、《中国西北地区侏罗系油气分布》、《中国南方海相油气地质及勘探前景》、《青藏高原石油地质》和《中国煤层气勘探》等卷,都系统总结了应用油气地质理论同相适应的新技术攻关的结合,由于这些新技术发挥了明显作用,因而近年的油气勘探中取得了一系列新的认识和重要的成果,这正是《中国油气新区勘探》这部著作的特色,值得一读。

中国科学院院士

王德纯

2001年5月25日