·中国海洋地质丛书之七·

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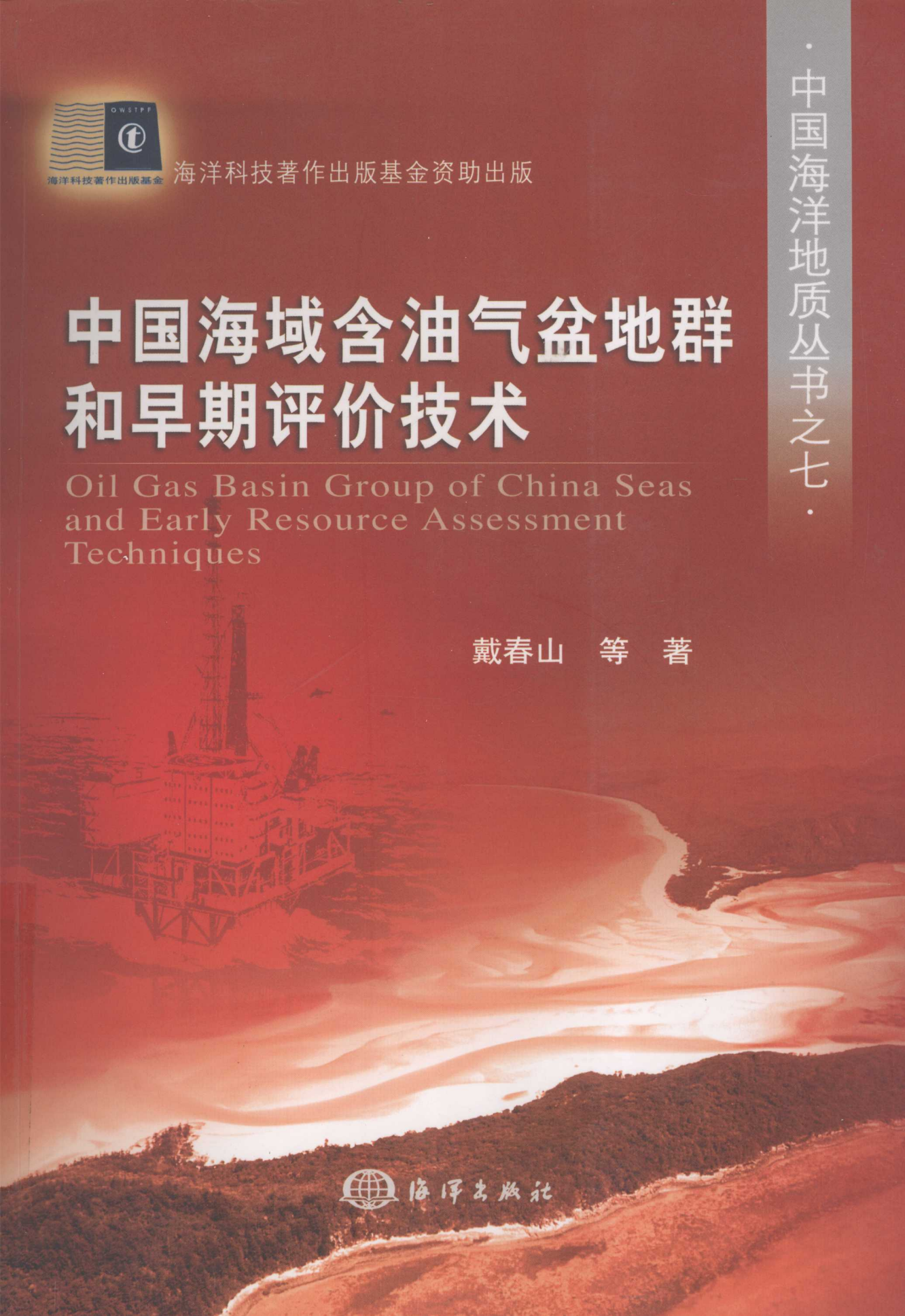
中国海域含油气盆地群和早期评价技术

Oil Gas Basin Group of China Seas and Early Resource Assessment Techniques

戴春山 等 著



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序

中国是个既不贫油也不富油的国家。不贫油，是说中国拥有较丰富的石油天然气资源，年产量已近2亿吨；不富油，是和俄罗斯、美国、沙特阿拉伯、伊拉克、伊朗等富油国相比，中国的油气资源比这些国家少得多，而人口又多得多，中国自产的石油天然气远不够用，现年进口量已超过2亿吨。

自中元古代以来，各地质时代中国均有油气生成，但由于后期构造的严重破坏，元古界、古生界和三叠系的海相油气主要赋存于塔里木、鄂尔多斯和四川3个多旋回叠合盆地。这3个地区构造相对稳定，遭受后期破坏的程度相对较轻，海相层之上都有巨厚的陆相沉积层的覆盖，使其中的油气得以保存。在中国，中、新生代多为陆相沉积，油气主要赋存于大、中型和少数小型沉积盆地；海相油气分布在海域的新生代盆地之中。从空间上讲，中国的石油天然气分为大陆和海洋两个区域。大陆西部有塔里木、准噶尔、柴达木和酒泉等盆地；中部有四川、鄂尔多斯以及海拉尔、二连等盆地；东部有松辽、渤海湾、苏北和江汉等盆地。海上油气分布于渤海、黄海、东海和南海等几个区域。

中国的油气地质已有多部著作论述，最新的一部是王金琪先生的《中国油气地质特征》，主要论述大陆油气地质。现在呈现在读者面前的《中国海域含油气盆地群和早期评价技术》是我国海上油气地质的一本最新著作。

本书第一作者戴春山先生是一位资深石油地质学家，他积40余年之实践，和他的同事共同完成的这部著作，把基础地质、石油地质和评价技术结合起来，系统总结了中国海域油气地质特征，提出了一系列有价值的见解。

在这本著作中，作者根据我国海域自20世纪70年代以来丰富的油气地质勘查资料，针对不同类型原型盆地和多旋回叠合盆地呈有序排列分布的特征，把处于同一板块位置上、成盆机制相同或相关的一组盆地称之为盆地群。将中国海域含油气盆地划分为渤海湾裂谷盆地群、黄海裂陷盆地群、东海弧后裂离盆地群和南海盆地群，后者又进一步分为：北部陆缘和南部陆缘裂陷盆地群，西部走滑盆地群，南缘和东北部前陆－裂陷盆地群。对比分析各盆地群的油气地质特征、油气远景和勘探方向后，作者认为，渤、黄海盆地为多旋回叠合盆地，具多套烃源岩系和复合含油气系统，新生代大陆裂陷（裂谷）阶段是主要成盆、生烃和成藏期，可形成与断裂密切相关的复合油气聚集带；东海盆地弧后裂离和挤压频繁交替是成盆和成藏的主控因素，新生代海相和海陆交互相含煤岩系烃源岩

是其重要特征，形成挤压背斜－断块成藏组合和较单一的含油气系统；南海盆地处于大陆离散边缘，新生代是主成盆期，以海相和海陆交互相沉积为主，持续稳定沉降是主要特点，一般形成较单一的油气系统，在南部裂陷和前陆盆地形成三角洲相和生物礁相的大型油气田群。作者还特别指出，南黄海盆地和四川盆地虽然同位于扬子准地台之上，但二者的油气地质条件却很不相同，埋藏史和成藏条件都有重要差异，不能等同视之。

在评价技术方面，作者把盆地建模和盆地模拟组合成统一的大型评价系统，并始终贯穿和融入专家分析和人工干预界面，充分体现了石油地质学家在盆地早期评价中的经验与智慧，提出了在含油气系统和成藏动力学理论指导下的综合评价技术。

在总结中国海上油气勘查历史之后，作者深有感触地正确指出，深入细致、全面的石油地质研究，高素质的地质学家在油气勘查战略决策和勘探方向的选择上，往往起着不可替代的重要作用。在当年技术条件相对落后的条件下，珠江口和东海陆架盆地，首钻井至发现井仅用了两年的时间。珠江口盆地从1975年开始油气调查，到1979年珠5井首获工业油流，仅用了5年的时间；东海盆地从1974年开始调查，1981年打第一口探井（龙井1井），1983年即在平湖1井发现工业油流。另外，大庆油田从1955年8月开始踏勘，到1959年9月松基3井出油，只用了4年多一点时间。这都得益于对地质、物探资料的精确分析，高素质地质学家的深谋远虑、高超的决策和指挥艺术。事实雄辩地证明：高水平的地质学家在相对落后的技术条件下，可以有重大发现；相反，低水平的石油地质“匠”用再先进的技术，也难以实现油气勘探的重大突破。

中国海域油气资源尚处于勘探开发的初期，资源潜力很大，南海的南沙群岛海域，更值得特别予以关注。相信戴春山先生等著的《中国海域含油气盆地群和早期评价技术》的出版，将对今后中国海上油气勘探战略选区和早期资源评价以及盆地的石油地质研究都具有重要的现实意义和参考价值。我热烈祝贺该书的出版发行！

中国科学院院士 任纪舜

2010.10.18

前　言

中国海域的油气勘探有两个问题尚待解决，一个是油气勘探战略接替和选区，另一个是对低勘探程度区的早期油气资源评价技术的研究问题。

作者于2000年完成了国家高技术发展计划（“863”计划）海洋领域“820”主题中“海上油气资源区域快速综合评价技术（820－03－03）”课题的研究，旨在解决油气资源早期评价技术问题，其目标任务是“研制一套主要针对已进行了地球物理概查和普查，而未钻探或钻井资料很少的盆地的早期快速综合评价技术，开发适应的评价系统”。该套评价系统研制成功后，经推广应用，取得了一定的效果，因此很想推荐给读者和同行们一阅，并指正。

关于海域油气勘探战略接替和选区的研究，应该说是一个庞大的系统工程，不是本书可以胜任的。众所周知，中国管辖海域及邻区分布有31个中、新生代沉积盆地，总面积达1 740 770 km^2，到目前为止，我国除对近海陆架区11个盆地进行了不同程度的油气勘探与开发外，尚有20个盆地我国只进行了地震概查和普查，但均未进行钻探，其研究和评价工作有待加强。但本书还是尝试从区域上探讨31个盆地的基本地质特征和成藏条件，从而为海域油气资源战略选区提供基础资料。

总之，上述两个问题可以说是本书编写的初衷和想法，全书共分为9章，第1章绪论，主要介绍了早期评价的任务、海区油气勘探历程的回顾和问题；第2至第4章，主要介绍了中国海域及邻区构造单元、演化期次和含油气盆地群，尝试按同一板块位置和地球动力学背景上的一组盆地（盆地群）来论述其成盆机制和含油系统，这一部分是本书的重点，相当于建立地质模型的研究。第5章至第9章主要介绍了在含油气系统理论指导下的早期油气资源综合评价技术，该项技术包括了综合地球物理和层序地层学盆地描述技术以及油气运聚为主的盆地模拟技术，以应用于海上盆地早期油气资源评价，这一部分是本书又一重点阐述的问题。

在本书初稿完成之后，感到对以下几个方面的研究有所进展或感悟，现简述如下，并供同行们讨论。

1. 以“盆地群”为区域构造单元，分析其成盆成藏特征

中国海域及邻区的31个中、新生代盆地，以不同类型的原型盆地和多构造旋回的叠合盆地的形式呈有序的分布。研究中把处于同一板块位置上的成盆机制相同或相关的一组盆地称之为“盆地群”。并在此基础上分析其源岩和成藏组合（Play）及含油气系统，为早期评价成藏条件的研究和资源预测提供依据。

根据上述思路，把海域中31个盆地分为陆内的克拉通－裂陷盆地群、西太平洋

活动大陆边缘的弧后裂离盆地群和华南及南海准被动陆缘的裂陷盆地群等三大类和五个亚类及九个盆地群。如南海准被动大陆边缘裂陷盆地群，其拉张裂陷是盆地演化的主幕，但伴随着南海小洋盆的产生和向南的裂离，使其在中新世和上新世时期，形成了不同性质的板块边缘和盆地群，如西部的伸展与剪切边缘的走滑－裂离盆地群（莺歌海、中建南和万安盆地），南海东北部和南缘的碰撞俯冲边缘上的前陆－裂陷盆地群等（台西和台西南盆地群；曾母、文莱－沙巴和西巴拉望盆地群）。从而为从区域上研究其成盆和成藏机制以及早期评价奠定了基础。

同时，本书对南黄海克拉通－裂陷盆地群进行了重点解剖，并与四川盆地进行了对比，认为两者之间在埋藏史和成藏条件上有较大的差异。而北黄海属隆起背景上“小克拉通”上的晚中生代裂陷的叠加盆地，与陆上的胶莱、安州等盆地组成了NE走向的晚中生代盆地群，并分别对南、北黄海盆地群的勘探方向进行了探讨。

2. 西太平洋边缘的东海和南海盆地群呈现向洋逐次裂离的演化特点

其中东海陆架盆地西部坳陷带的主裂陷期为K—E_1，东部坳陷带至南海北部的珠江口、琼东南盆地的主裂陷期为E_2，而南海南部的万安、曾母盆地的主裂陷期为E_3^2—N_1^{1+2}，至冲绳海槽盆地的主裂陷期为N_2—Q；反映了由于太平洋等板块俯冲、地幔物质向东蠕散而引起的裂陷中心向洋迁移的演化特点。而且由于持续向洋拉张裂陷和向陆一侧的断块挠倾的原因，造成几乎所有的裂陷盆地均呈东断西超或东南断向北西超覆的几何形态。上述演化特点对盆地主力烃源岩的分布和成藏系统的类型起到了重要的控制作用。

3. 中国海域含油气盆地群油气地质特征对比

对中国海域含油气盆地群的成盆机制、成藏组合和含油气系统进行了对比。其中黄、渤海克拉通（内）盆地群属多构造旋回的叠合盆地，形成了多套烃源岩系和复合的含油气系统；但新生代的裂陷（裂谷）阶段是本区的主要的成盆、成烃和成藏期，油气运移距离较短，形成了与断裂密切相关的油气运聚体系和成藏组合，以及极具特色的复式油气聚集带。东海弧后裂离盆地群，位于华南褶皱系之上，新生代以来的弧后裂离和挤压反转的频繁交替是成盆和成藏的主要控制因素，古近系含煤岩系生烃是其重要特点，常形成以古近系挤压背斜－断块成藏组合和较单一的含油气系统。南海被动大陆边缘盆地群处于岩石圈离散边缘，中－新生代以来太平洋和印－澳板块的双向俯冲诱使地幔流上涌，造成被动裂陷作用；新生代是其主成盆期，以海相和海、陆交互相沉积为主，持续沉降是其重要特点，油气沿较均质的海相输导层可进行长距离运移，形成了较单一的含油气系统，和沿（地）缝合线周围分布的三角洲相和生物礁相的大型油气田群。

4. 高素质的专家思维在盆地早期评价中的重要作用

油气勘探的价值在于发现，而且是石油地质勘探活动中难度最大和最有挑战性的工作。这其中高素质专家的思维起到了重要作用。对此，作者在总结了我国海域中的油气勘查史后感触颇深。这其中尤其是珠江口和东海陆架含油气盆地的发现，

突出地反映了石油地质学家和决策层的能力及业务水平。这两个盆地的首钻井至发现井的周期仅为两年,而珠江口盆地从开始油气地震调查(1975 年)到珠 5 井首获工业性油气流(1979 年)仅用了 5 年时间,这是在当时勘探技术尚不先进的条件下的成功事例,充分体现了地质学家的业务素质。而东海陆架含油气盆地的发现也是一个非常成功的范例,外国公司于 1970 年在该区开始油气调查,1972 年在东海陆架盆地福江凹陷钻探了第一口探井—福江 1 井失利,至今未获得工业性油气流。我国于 1974 年开始油气概查和普查,1981 年 3 月钻探第一口井(龙井 1 井),而在 1983 年钻探的西湖凹陷平湖 1 井就获得了工业性油气流,实现了东海油气勘探的重大突破,并随即转入圈闭预探和油气藏评价阶段;其勘探阶段划分鲜明,勘探程序严谨,反映了石油地质学家和决策者的高素质和高水平。因此,无论从维护国家权益的社会效益还是经济效益上讲,东海的油气发现都是值得骄傲的一座历史丰碑。

5. 海上油气资源区域快速综合评价技术

(1)评价系统构成:由盆地描述技术和盆地模拟技术两大部分组成,盆地描述技术建立地质模型,盆地模拟技术进行资源量和分布的预测。包括:①综合地球物理盆地描述技术,是在多道地震为主的建模基础上,采用三维层析成像技术进行盆地模型的描述和修正,其关键技术是地震波走时的计算机自动识别和拾取、三维地震波场和时间场正演模拟,以建立盆地的构造模型。②层序地层学盆地描述技术,是根据层序地层学、旋回地层学和米兰科维奇理论的原理,对盆地层序和体系域进行分析,直观地对盆地的沉积环境进行描述,以确定成烃环境和生储盖组合。并研制了层序地层模型库、构造沉降和沉积基准面分析、岩性预测、模拟井和沉积相成图等一体化的评价系统。③油气运移聚集为主的盆地模拟技术,研究中采用重点研制和集成相结合的方法,研制成功了超压和流体势模拟技术、二维成藏动力学模拟技术、多层多次有限拉张热演化正演技术等,实现了专家智能判别与成藏动力学相结合的油气运移和聚集的模拟技术,提高了盆地早期油气资源分布的预测水平。

(2)评价系统的特点:①含油气系统理论指导下的一体化的综合评价技术,地质模型的建立是资源评价的核心和基础,以往的评价技术,人为地分割了地质模型建立和盆地模拟的“母子”血缘联系。这次研制的评价技术,将盆地描述建模和盆地模拟资源评价技术编制成统一的大型评价系统,以 Sun 工作站为硬件平台,实现了盆地描述与盆地模拟子系统的有机联接。②体现了专家思维和智能,为了充分体现石油地质学家在盆地早期评价中的经验和判断,在整个系统中始终贯穿和融入专家分析和人工干预界面,体现了专家的思维和智能。

6. 编著者分工说明

本书是在国家“863”计划 820 - 03 - 03 课题基础上编写而成。参加编写的单位有国土资源部青岛海洋地质研究所、中国科学院地质地球物理研究所、中国地质科学院、中国海洋石油总公司勘探开发研究中心、广州海洋地质调查局和中国地质大学等。全书共分 9 章,戴春山完成了第 1、2、3、5 章的编写;第 4 章由戴春山、杨艳秋编

写,并编制了相关的图件;杨艳秋完成了北黄海、南黄海和东海盆地群地层与构造方面的编写工作,蔡峰、李刚参与了黄海盆地群的研究和编写工作。第6章由于常青、吴志强编写,第7章由刘伊克、常旭编写,第8章由陈建文、龚建明、于常青、戴春山、徐华宁、高红芳、梁杰、符溪、白志琳等编写,第9章由温珍河、林峰、曾荣佳、仝志刚、胡根成、戴春山、王明君编写;最后由戴春山统编定稿。杨艳秋完成了全书有关图件复制和编辑工作。

本书在编写和出版过程中得到了国家"863"计划海洋领域"820"主题专家组陈邦彦教授级高级工程师、国土资源部科技司高平处长和青岛海洋地质研究所以及项目合作研究各单位的帮助和支持,并得到了海洋出版社有关领导和编辑的协助,在此表示衷心感谢。

《石油与天然气地质》主编、中国石油化工集团公司勘探开发研究院王庭斌教授对全书进行了认真审阅,并提出了许多宝贵的修改意见,同时本书在编写过程还引用了国内外学者大量的文献以及一些尚未出版的文稿,在此也一并致谢。

同时,本书在编写过程中还得到刘守全研究员、莫杰研究员和郭振轩先生的大力帮助,青岛海洋地质研究所海洋油气与水合物资源调查研究室有关同仁提供了资料,在此表示衷心感谢。我的夫人何金贵工程师在本书的生物地层研究方面参与了讨论和咨询以及生活上的支持,使编写工作得以顺利进行。全书文稿打印由青岛海洋地质研究所图形公司赵辉先生完成,刘梅女士完成了部分图件的绘制工作,也在此表示衷心感谢。

应该指出,本书涉及的学科和技术很多,而且还有很多问题尚待解决。因此在编写过程中作者深感知识的不足和欠缺,已预感到本书存在不少问题和错误,恳请读者批评指正,以求不断完善和改进。

2010年7月

Preface

There are two issues to be resolved in oil and gas exploration of China Sea, one is the strategic petroleum area selection, and the other is the early-phase oil and gas resources assessment techniques for the low-level exploration area.

In 2000, the authors completed a project (820 – 03 – 03) called "Fast comprehensive assessment techniques for offshore hydrocarbon resources", which is part of National High Technology Development Program (863 Program). The project is aimed at early evaluation of oil and gas resources. The task of the project is to develop a set of evaluation system for the basins which have been got geophysical survey without drilling or a few drilling data. After the evaluation system was successfully developed, some achievements have been got, therefore, we would like to recommend the system for you to correct.

With regard to offshore strategic petroleum area selection, it should be considered as a huge systematic project. As everyone knows, there are 31 Mesozoic and Cenozoic sedimentary basins in China's jurisdictional waters and adjacent areas, with a total area of 1 740 770 km^2, until now, 11 offshore shelf basins have carried out different levels of oil and gas exploration and development, there are 20 basins have done a few seismic investigations and survey which need to do further works. However, this book also attempts to regionally probe into the basic geological features and reservoir conditions of 31 basins, providing the basic data for strategic petroleum area selection.

In short, the two questions mentioned-above can be regarded as the original intention for this book to be written. The book is divided into nine chapters. The first chapter is introduction, focusing on tasks of early evaluation, reviewing marine oil and gas exploration history and discussing the existing issues. The 2nd to 4th chapters, which mainly describes the tectonic units, evolution period of times and hydrocarbon-bearing basin group in China sea waters and its adjacent area, try to describe basin-forming mechanisms and oil systems based on the same plate position and geodynamic background of basin group. This part is equivalent to the establishment of the geological model which is the focus of this book. The 5th to 9th chapter introduces the theory of petroleum system in the early oil and gas resources under the guidance of a comprehensive assessment of technology, which includes an integrated geophysical and sequence stratigraphy technology, and oil and gas migration and accumulation under the basin-based simulation techniques , these techniques can be applied to offshore oil and gas resources early assessment . This part is highlighted in this book.

After the completion of the first draft, some aspects or sentiment of the research progress are summarized for colleagues to discuss as follows.

1. Take "the basin group" as the regional tectonic units, analyzing their basin – forming characteristics

Thirty-one Mesozoic and Cenozoic basins in China seas and adjacent areas showed an orderly distribution in different types of prototype basin and multi-tectonic cycle in the form of superimposed basins. A group of basins with similar or related basin-forming mechanism at the same plate location are called the "basins group. "On this basis, analysis of their source rocks and reservoir combinations (Play) and the petroleum system can provide the basis for the early evaluation of reservoir-forming conditions and resources.

According to the mention-above ideas, the 31 basins in China sea are divided into crat on – rift basin groups within the land, back-arc rift basin groups on the Western Pacific active continental margin, and rift basin groups on the quasi-passive continental margin along the South China and South China Sea, with the total of three major categories and five sub – categories. Such as the rift basin groups on the quasi-passive continental margin along the South China Sea, in which extensional rift is the main screen of the basin evolution, but accompanied by the generation and southward cleavage of South China Sea oceanic basin, forming different plate boundaries and basin groups in the Miocene and Pliocene. Such as the slip-split groups on the western extension and shear edge (Yingge Sea Basin, zhongjiannan basin and Wanan Basin), the foreland-rift basin groups on the edge of the crash subduction of northeastern and southern South China Sea(Taixi and Taixinan basin group; Zengmu , Brunei—Sabah and west Palawan basin group). As a result, these studies are laid the foundation of basin – forming and the accumulation mechanisms from the region, as well as the early appraisal

At the same time, this book preferentially dissected the South Yellow Sea Craton-rift basin group and compared with the Sichuan Basin, considering that there is a large difference between the two in terms of burial history and reservoir conditions. North Yellow Sea basin is the superimposition basin of late Mesozoic "small Craton" in the uplift background, the late Mesozoic basin groups in the N – E direction are constituted with onshore Jiaolai, Anzhou and other basins, this book discussed exploration direction of the south and north Yellow Sea Basin Group respectively.

2. The East China Sea and the South China Sea basin group on the edge of West Pacific Ocean presents the evolution features of cleavage gradually to the ocean

The main rift period of the west depression on the East China Sea continental shelf basin (ECSCSB) is K—E_1, the eastern depression of ECSCSB to the Pearl River Mouth basin and Qiongdongnan basin on the north of South China Sea is E_2, while the Wan-an, Zengmu basin of the South China Sea is E_3^2—N_1^{1+2}, to the Okinawa Trough rift basin is N_2—Q; It reflects evolution characteristics of the rift center migrated to the ocean, which were caused by Pacific

plate subduction and mantle material creeped eastwardly. Moreover, because of extensional rifting to the ocean constantly and the block torsion to the landward, caused almost all rift basin presented the geometric shape of the east rupture west overlap or east-south rupture to northwest overlap. The above evolution features play an important role on the distribution of favourable hydrocarbon source rocks and reservoir system in basin.

3. Comparison of petroleum geological features of oil and gas-bearing basin group in China sea area

The mechanisms of forming-basin, forming-reservoir combinations and petroleum systems of oil and gas-bearing basin group in china sea area were compared, within which the Yellow Sea and Bohai Sea craton (inner) basin group is a multi-tectonic cycle of superimposed basins, forming a number of sets of hydrocarbon source rocks, and a composite petroleum system; but the rifting (rift) phase in the Cenozoic Era is the main period of basin generation, hydrocarbon generation and accumulation in the local place, oil and gas migration is short, forming the oil and gas migration-accumulation system, and accumulation combination closely related with the rupture, as well as multiple oil and gas accumulation zone with unique features. East China Sea back-arc rift basin group is located on the South China fold system. The back-arc cleavage and the squeezing reversal frequently alternation in the Cenozoic Era is the main control factors of the forming-basin and the accumulation. The Paleogene coal-bearing rocks generated hydrocarbons, which is an important character, The back – arc rift basin group often forms a Paleogene Anticline-block accumulation combination and a more single petroleum system. The South China Sea passive continental margin basin group lay discrete edge of lithosphere, the two-way subduction from Pacific plate and the Indian – Australian plate in the Mesozoic – Cenozoic induce the flow of upwelling mantle, resulting in the role of passive rifting; Cenozoic is the main period of the basin-forming, the deposits consisted of sea facies and the sea-land facies, the sedimentation constantly is an important feature, oil and gas migrate long-distance along the relatively homogeneous marine transporting layer, forming a more single petroleum system, and a large-scale oil and gas fields group of the delta facies and biological reef facies distributed along the (place) suture.

4. High-quality experts thinking plays an important role in the early evaluation in the basin

The value of oil and gas exploration is the discovery, and which is the most difficult and most challenging work in the oil geological exploration activities. Among which the thinking of highly qualified experts play an important role. In this regard, the author had some deep feelings on the basis of summing up the oil and gas exploration history in the China Sea. Among these, especially the discovery of the oil and gas-bearing basin of the Pearl River Mouth basin and East China Sea continental shelf distinctly reflects the ability and professional level of petroleum geologist and decision – making. The cycle of the first drilling well to discovery well is only two years in these two basins, it just took five years from seismic surveys (1975) to the

Zhu five well got industrial oil and gas flow (1979) in the Pearl River Mouth Basin, which is the successful story at the time under the conditions of exploration technology is not advanced, fully embodies the operational quality of the geologist. And the the discovery of oil and gas bearing basin in the East China Sea shelf is also a very successful example, foreign oil companies firstly investigated oil and gas in 1970 at this area, in 1972, the first exploration well – Fujiang 1 well was drilled in the Fukue depression of the East China Sea shelf basin, which was lost and has not obtained industrial oil and gas flow. In 1974, China carried out the oil reconnaissance survey and general survey in East China Sea, the first well (Longjing 1 wells) has drilled in March 1981, while the Pinghu 1well was drilled on the Xihu Depression obtainning industrial oil and gas flow in 1983, realizing a major breakthrough of oil and gas exploration in the East China Sea, and then transferred to trap pre – exploration and reservoir evaluation phases; its clear-cut division of the exploration phase and rigorous exploration program, reflecting the high-quality and high-level of petroleum geologists and decision – makers. Thus, in terms of social interests from safeguarding national rights or economic interests, the oil and gas discovery in East China Sea is a proud historical monument.

5. Fast comprehensive assessment techniques for offshore hydrocarbon resources

(1) The evaluation system constitution: basin description technique building the geological model and basin simulation technique forecasting resources and its distribution. Including: ① integrated geophysical basin description of technology, mainly in multi-channel seismic modeling, based on a three-dimensional tomographic imaging techniques described in the model basin, and amendments to the key technology is the seismic wave travel time of the computer automatically recognizes and pick-up, Three-dimensional seismic wave field and time field forward modeling in order to establish tectonic model. ② basin sequence stratigraphy description technique is based on sequence stratigraphy, Milankovitch cycle stratigraphy and the theory of principle, the basin sequence and system tract analysis, intuitively depositional environment of the basin are described in order to determine the environment and the source-reservoir-cap combination. And the development of a model library sequence stratigraphy, tectonic subsidence and deposition of base-level analysis, lithology prediction, simulation wells and deposition complementary to each other diagrams integrated evaluation system. ③ hydrocarbon migration and accumulation of basin-based simulation technology, research focus on developing and integrating the use of a combination of methods, successfully developed an ultra-pressure and fluid potential simulation technology, two-dimensional reservoir dynamics simulation technique, multi-layer multiple limited tensional thermal evolution forward technology to achieve an expert intelligent discrimination and accumulation kinetics of a combination of oil and gas migration and accumulation of analog technology to improve oil and gas resources of the basin, the distribution of the early forecast level.

(2) The characteristics of the evaluation system: ① highlighting the comprehensive think-

ing. Integrated evaluation technique is guided by petroleum system theory, building of geological model is the core and basis of the resource evaluation, previous evaluation techniques usually artificially cut the geological model building and basin modeling. The new evaluation techniques build a single large-scale evaluation system linked with basin description modeling and basin modeling resources evaluation techniques, through Sun workstation as the hardware platform to achieve the basin description and basin modeling subsystems of organic links. ② reflecting the thinking of experts and intelligence, in order to fully reflect the the experience and judgments of petroleum geologists in the early evaluation, expert analysis and human intervention interface has always run throughout the system, reflecting the thinking of experts and intelligence.

6. Editors

This book is composed of the study results of the national "863" program 820 - 03 - 03. Editers are composed of Qingdao Institute of Marine Geology, Ministry of Land and Resources, Institute of Geophysics, Chinese A cademy of Sciences , Chinese Academy of Geological Sciences, China National Offshore Oil Corporation Exploration and Development Research Center, Guangzhou Marine Geological Survey and China University of Geosciences and so on.

The book is divided into nine chapters, Dai Chun-shan completed the first, second, third and five chapters; fourth chapter from the Dai Chun-shan and Yang Yan-qiu; Cai Feng, Li Gang participated in the study in section 3 of fourth Chapter, and sixth chapter from Wu Zhiqiang and Yu Changqing, seventh chapter from Liu Yi-Ke and Chang Xu, eighth chapter from Chen Jian-wen, Yu Chang-qing, Gong Jian-ming, DAI Chun-shan, Xu Hua-ning, Gao Hong-fang, Liang Jie, Fu Xi, Bai Zhi-lin, ninth chapter from WEN Zhen-he, Lin Feng, Zeng Rong-jia, Tong Zhi-gang, Hu Gen-cheng, DAI Chun-shan, Wang Ming-jun; and finally compiled by the DAI Chun-shan. Yang Yan-qiu completed maps and editing, Yan Guijing made some amendments for some chapters.

In the preparation and publication of this book, we got a lot of helps from Professor Chen Bangyan who is the expert of marine areas "820" theme group of experts of National "863" plan , Cao Ping who is Director of the Division of Science and Technology of MLR, Qingdao Institute of Marine Geology, cooperative units, and leaders and editorsof China Ocean Press, thus to express my sincere gratitude.

Chief editor of Oil & gas geology, Professor Wang Tingbin, from China Petroleum & Chemical Corporation Exploration and Development Research Institute carried out a careful review of the book and made many valuable amendments, in the process of preparing this book, we also cites a large number of literature scholars at home and abroad as well as some unpublished manuscripts, in this also to thank.

At the same time, the book also received great help during the preparation process from researchers Liu Shou-quan, Mo Jie and Mr. Guo Zhen-xuan, colleagues from Division of Oil

and Gas Resources of Qingdao Institute of Marine Geology provided a lot of information, we wish to express our heartfelt thanks. My wife, engineer He Jingui participated in the discussion and consultation about the biostratigraphic research of the book , as well as life support, so that the preparation work can be carried out smoothly. The book manuscript is printed by Mr. Zhao Hui from Graphics Inc. of Qingdao Institute of Marine Geology, while Miss Liu Mei completed some mapping work, we would also like to express my sincere gratitude.

It should be noted that this book involves many disciplines and technologies, but there are still many issues to be resolved, therefore, the authors deeply feel the deficiencies and lack of knowledge in the preparation process, and have anticipated the problems and errors in this book, we urge readers to criticize so as to continually refine and improve.

Dai Chun Shan

July, 2010

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