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——以潍北盆地为例

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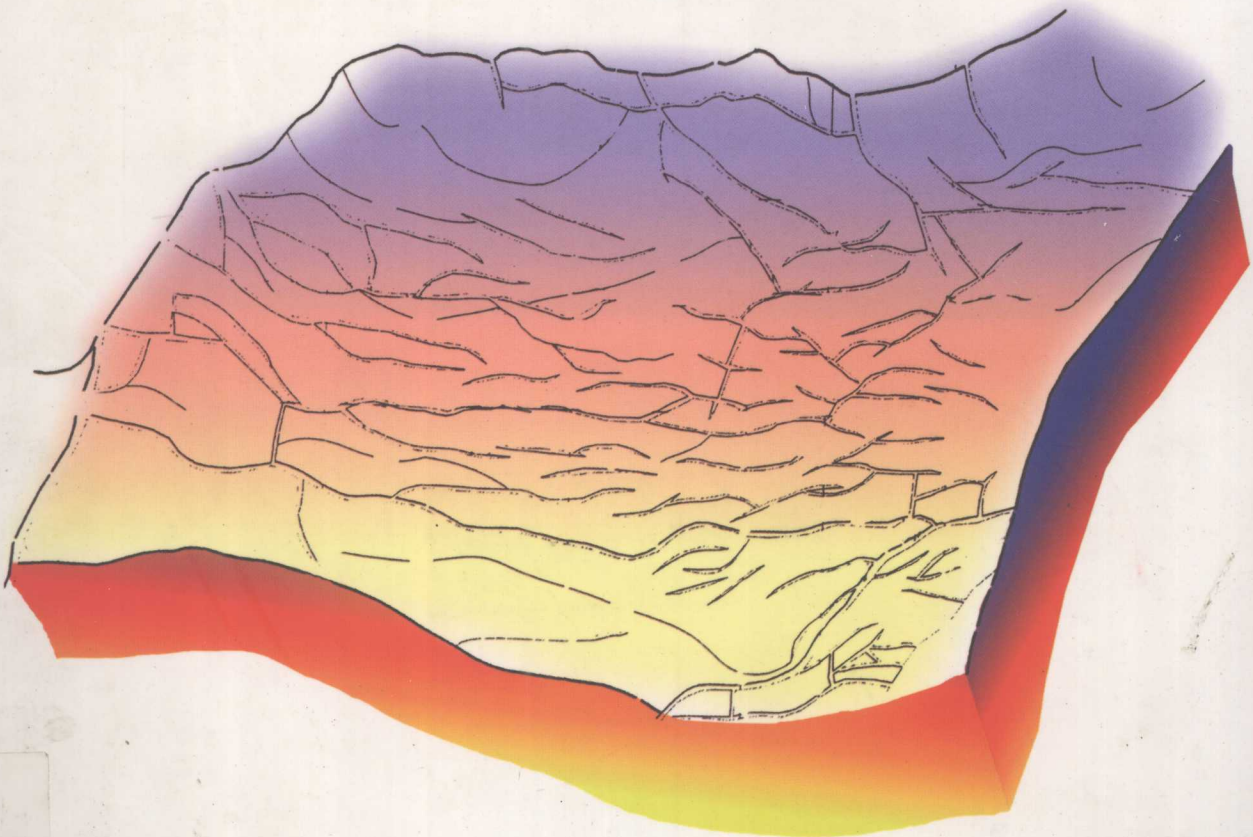

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序

油气是人类赖以生存、发展的重要能源，它关系着国家的经济安全和社会稳定。随着我国经济的持续发展，对油气的需求正在日益增加。摆在中国油气地质勘探学家面前的任务，不仅要大力加强新区油气资源勘查，开拓新的领域，同时要继续深化老区油气资源增储上产，挖掘新的潜力。为促进我国油气地质学理论的发展，为提高我国油气资源对经济社会可持续发展的保障能力，做出应有的贡献。

走滑拉分盆地是沉积盆地的类型之一，其丰富的油气资源已被国内外许多勘探和研究所证实。近年来中国海洋石油集团公司与美国菲利普斯石油公司合作，在中国东部海域发现了蓬莱19-3等大油田，进一步证实了与中国东部郯庐走滑断裂带伴生的沉积盆地有着良好的油气勘探远景。

《拉分盆地分析与含油气性》一书着重论述了沉积盆地分析的核心问题——沉积盆地地球动力学过程和油气藏形成要素与动态过程。

沉积盆地地球动力学主要研究内容包括沉积盆地的形成演化和沉积盆地的充填层序。

沉积盆地的形成演化是盆地地球动力学研究的重要内容。作者在大量翔实资料基础上，通过对盆地构造形变、深部热机制分析、成盆过程动态演化过程分析，提出了潍北盆地是受郯庐断裂走滑作用控制的拉分盆地，自晚白垩世以来经历了走滑裂陷—拉张断陷—走滑挤压—坳陷沉降和挤压等五个阶段，不同原型盆地是在不同的地球动力学背景中产生和演化的，并由此具有全然不同的特征。

沉积盆地的沉积充填层序研究是盆地地球动力学研究的另一重要内容。作者通过地震、钻井岩心、测井等“三位一体”层序分析方法，建立了盆地充填的层序地层格架，恢复了不同时期岩相古地理面貌，确定盆地中沉积体系三维配置关系，为建立拉分盆地层序地层特征提供了有用的参考资料。

油气在地壳上的分布、聚集不是无序的，而是有序可循的。在对含油气盆地进行油气勘探时，通常要解决三个层次的问题，即盆地评价、区带优选和钻探目标确定。传统的研究

思路偏重生、储、盖等成藏要素的静态定性描述。含油气系统理论问世以来，油气地质勘探家倾向于从油气系统的角度对上述三个层次的问题作出客观的回答。因为含油气系统给人们提供了一个油气从有效源岩运移到圈闭的评价方法，不仅回答油气成藏要素组合的定性描述，而且强调油气从有效源岩运移到圈闭的动态过程，使盆地评价更为客观，区带优选更加可信，目标确定更趋可靠。作者采用的镜质体反射率正演模型技术，对不同构造单元的重点探井的烃源岩热演化进行模拟计算，在此基础上勾绘出潍北拉分盆地含油气系统范围，为指导该盆地的深化勘探有重要价值。

此外，作者在书中还探讨了潍北盆地天然气成因，指出该区不仅存在油型气、煤型气，而且还发育细菌气，为拓展天然气勘探领域提供了理论依据。

总之，李晓清、汪泽成等著的《拉分盆地分析与含油气性》是作者运用现代沉积盆地地球动力学、油气地质学理论和新的油气地化、沉积、构造研究方法与技术，对渤海湾地区潍北拉分盆地进行多学科综合、系统总结、深化认识、重新评价基础上编写而成。该书不仅对潍北盆地与郯庐走滑断裂带伴生的沉积盆地，而且对其他的走滑拉分盆地的理论分析和油气勘探均有重要参考意义。

潍北盆地油气田的发现是胜利油田众多勘探家们四十年艰苦奋斗的成就，该书是东胜精攻石油开发集团有限公司的油气勘探家们承前启后、勇于实践、勤于思考、不断开拓的结晶，可喜可贺。该书的出版将在我国走滑拉分盆地分析与含油气研究领域新增一部具有理论与实际价值的重要文献。

值该专著问世之际，特为序，表示祝贺。

中国科学院院士 刘宝珺

前 言

走滑盆地作为沉积盆地的类型之一，近年来，其丰富的油气资源已引起国内外石油勘探家的高度重视。潍北走滑盆地的形成与郯庐断裂带演化密切相关，油气资源丰富。由于盆地构造复杂，油气富集规律认识不足，虽历经几十年的勘探与开发，但其石油探明储量未有大的增长，油气探明率低，勘探进入了一个艰难时期。走滑盆地与其他类型的沉积盆地相比，在构造、沉积特征、油气成藏、油气富集规律与控制因素等方面存在显著不同。本书以潍北盆地为例，在前人研究工作的基础上，采用断陷—走滑盆地构造地质学、层序地层学和含油气系统的研究思路与方法，运用多种分析、化验等技术手段，详细论述了走滑盆地的构造特征与演化、沉积层序与储层特征、烃源岩地球化学特征，进行了油源对比和天然气成因分析，总结了走滑盆地的油气富集规律及控制因素，这对相似类型盆地的油气勘探，具有重要的借鉴意义。

潍北盆地位于山东昌邑县、潍县北部以及寿光县东北部，属滨海平原，地表为第四系冲积平原所覆盖，区内地势平坦，北部与海滩相接，南北向河流发育，较大的河流有白浪河、潍河等，区内人口密集、村庄众多，交通便利，南部为发达的农业区，北部属于泥质海滩，多为盐田、虾池等水产养殖区。

潍北盆地是郯庐断裂带中段沂沭断裂带中的一个中新代小型沉积盆地，面积为880 km^2。主要矿产资源为石油和天然气。据作者估算生烃量为17.9×10^8t，石油资源量0.97×10^8t，天然气资源量$104\times10^8m^3$。目前已探明石油地质储量$1\,431\times10^4$t，石油资源探明率不足15%，探明天然气储量$5.79\times10^8m^3$，仅占资源量的5.6%。推测油气勘探还有很大潜力。潍北盆地的勘探工作较早，1959年地质部石油局综合研究队在潍北盆地南部斜坡钻探潍1井。1960年山东地质厅803队进行了1∶10 000的重磁勘探，对盆地的区域构造轮廓有了较明确的了解。1966年，地质部石油地质综合研究队对该区的中—新生代构造和油气分布规律进行了研究。潍北盆地油气勘探始于1970年，按勘探程序可分为四个阶段：

普查阶段(1970～1982)：通过地震普查落实了潍北盆地的基本构造格局，为开展油气勘察提供了依据。期间实施了光点记录地震、模拟单次或多次覆盖地震，测网密度达1.2 km×1.2 km。1972年底完钻昌参1井，证实潍北盆地具有良好的生、储、盖组合。1973年4月底完钻昌参2井在孔二段发现9 m厚的油层，试油获工业油流，潍北盆地首次发现油气；同年10月完钻的昌3井获得日产百吨的高产，从此掀起了潍北盆地油气勘探的高潮。

地震详查阶段(1983～1984)：随着油气勘探工作的深入，发现该区油气地质条件相当复杂。截止1982年底，共钻探井26口，只有10口井获工业油气流，且多数井产量较低。为进一步落实构造，查明潍北盆地的油气地质特征，1983～1984年又展开了以数字二维地震为标志的地震详查，二维地震测线密度达到0.6 km×0.6 km。

地震精查阶段(1985～1992):随着油气地震勘探技术的发展以及三维地震勘探技术的成熟,1985年起潍北地区步入三维勘探时期。先后实施三维地震面积420 km^2,覆盖了潍北油田主体。通过三维地震勘探,进一步落实构造,深化油气地质认识,推动了潍北油田的勘探开发。

滚动勘探开发阶段(1993～至今):1995年始潍北盆地的勘探开发由东胜精攻石油开发集团有限公司负责,范围以潍北油田为主体。

目前,潍北盆地已完成二维地震测线近5 000 km,三维地震面积为420 km^2,覆盖了潍北油田的主体。区内共钻探井117口,开发井50多口,探明含油面积19.9 km^2,石油地质储量1 431×10^4t,已达到中等勘探开发程度。但多数井都位于灶户断鼻带,且在层系上也只局限于孔一段和孔二段,因此,潍北盆地无论是在区带上,还是在层系上都还具有广阔的勘探领域和较大的勘探潜力。前人针对潍北盆地的油气地质研究论著主要有:《潍北凹陷孔店组沉积相特征及油气聚集规律》,唐其生等,1992;《潍北凹陷天然气的勘探前景及勘探目标》,陈云林等,1995;《济阳、昌潍坳陷第三系深部砂岩储层成岩演化特征及新方法的应用》,蔡进功等人,1996;《潍北凹陷孔店组沉积特征及砂体地震解释》,陈东等,1992。这些研究成果对潍北盆地的油气勘探有着重大指导意义,也是我们研究潍北盆地地质构造性质、沉积特征与含油气性的重要基础。

前人通过研究对潍北盆地油气地质特征有以下几点认识:

基本查明潍北盆地构造形态,并将其定为是以下第三系孔店组为主、呈北断南超的箕状沉积盆地。但构造复杂,较难落实。

认为潍北盆地的主要烃源岩以孔二段暗色泥岩和碳质泥岩为主,成熟度较高,进入了生油和生气阶段。但各种类型有机质的成油和成气贡献尚不清楚。

认为孔店组沉积总体为断陷湖盆沉积,沿边界大断裂扇体发育,并可能成为岩性油气藏勘探的主体。但对扇体成因及岩性油气藏的形成条件缺乏深入研究。

认为潍北盆地的油气主要聚集于以灶户断鼻带为代表的高断块,油藏具有含油气条带窄、含油气井段长的特点。但认识程度不够。

1995年第二轮油气资源评价认为,潍北盆地具有1.22×10^8t石油和187×$10^8$$m^3$天然气资源量。但由于勘探程度和资料有限,有关参数的选择还有待深入分析,计算结果有待商榷。认为目前的探明储量与资源量、产量与探明储量之间甚不相称,并指出潍北盆地北部陡坡带具有较大的天然气勘探潜力。

本书在研究过程中主要应用了以下新理论和新技术:

成盆构造史研究:采用盆地分析技术和构造平衡剖面技术,查明盆地类型、构造样式、成盆机制和区域构造成因联系,探讨盆地构造的几何学、运动学和动力学特征。

盆地沉积充填史:运用层序地层学与沉积地质学原理,研究层序地层学特征、沉积体系展布、演化及储集砂体分布规律。

烃源岩评价与油气源对比:利用油气碳氧同位素测定及烃源岩测井判别等先进技术,研究主力烃源岩的生烃潜力、分布,油气与源岩的对比。

储层特征与评价:应用储层沉积——成岩作用原理,储层横向预测及储层评价技术,查明储层特征、评价储层。

油气资源评价:研究油气生烃史、排烃史和运聚史,对油气资源重新评价。

含油气系统研究:运用含油气系统理论和方法,分析油气成藏要素、动态过程及含油

气系统特征与油气富集规律。

油气勘探有利区带和目标评价：在盆地油气地质、地震、测井、测试综合研究基础上，采用区带和圈闭描述技术，提出勘探有利区带和目标。

作者通过对潍北盆地构造、沉积、地化及含油气性的系统研究，取得以下新的认识：

1. 潍北盆地性质属于走滑拉分盆地。

2. 潍北盆地构造演化可分为的五个阶段：①白垩纪的走滑裂陷期；②孔三段沉积期的走滑裂陷作用；③孔二段—沙河街沉积期的拉张断陷作用；④渐新世沙河街晚期，走滑挤压作用阶段；⑤晚第三纪区域坳陷沉降阶段和挤压阶段。

3. 采用层序地层学观点，进行地震、钻测井层序地层分析，将孔店组划分为1个二级层序，5个三级层序，10～12个体系域和30～40个准层序，建立了潍北拉分盆地层序地层格架。

4. 首次以层序、体系域为单元编制盆地孔店期沉积环境图。指出SQ_2层序的EST体系域为盆地主要烃源沉积环境，SQ_3层序的LST体系域和SQ_4层序的LST体系域、EST体系域为盆地主要储层沉积环境。建立了潍北拉分盆地孔店期沉积模式。

5. 首次编制定量反映成岩作用平面变化的储层成岩作用综合系数图、视压实率图和视胶结率图等，为储层评价提供了重要资料，并采用岩石储集相的概念，以体系域为单元，对储层进行综合评价。

6. 从有机质分布、有机质类型、丰度及成熟度等方面，系统分析了孔店组孔二段烃源岩的地球化学特征。指出孔二段源岩有机质丰度高，以Ⅱ—Ⅲ型为主，是本区主要有效的烃源岩。

7. 首次采用镜质体反射率正演模型技术，对不同构造单元的重点探井的烃源岩热演化进行模拟计算。研究认为北部洼陷孔二段成烃时间早，在孔一段沉积早中期进入低成熟门限，沙四段早期进入成熟门限，馆陶组末期和明化镇组早期达生烃高峰期。现今孔二段大部分处于生烃高峰演化阶段。

8. 根据含油气系统研究思路与方法，提出潍北盆地存在以北部洼陷为主和东南部灶户地区为辅的两个有效生烃灶；结合烃源岩热演化，指出孔二段含油气系统形成关键时刻为沙河街组末期和现今；油气运移通道主要有三类，即断层、砂岩层及不整合面；确定了含油气系统在平、剖面上的分布。

9. 潍北盆地石油可分为低熟油、成熟油两类，腐泥型＋偏腐殖型烃源岩是潍北盆地南部地区低熟油的主要源岩。采用多种地球化学指标，进行了油—源对比、气—源对比，认为潍北盆地的油气运移距离较近，为近源油藏。

10. 潍北盆地天然气成因类型多样，可划分为细菌气、细菌—成熟油型气、低熟煤型—油型气、成熟油型—煤型气和高熟煤型气五种类型。认为南部主要为细菌气，中部主要为低熟煤型—油型气和成熟油型—煤型气，北部深洼陷区主要为煤型气，盆地东南成熟油型气的形成是受岩浆异常热源影响而形成的。

11. 潍北拉分盆地油气富集规律具以下特征：1）走滑拉张作用，控制了沉积体系演化，形成了有利于成油母质（型）与成气母质（型）的共生，使得盆地既富油又富气；2）与主断裂共生的扇体，为岩性油气藏的形成提供了有利的储集空间；3）拉张与挤压应力场的并存，形成了多种类型的圈闭；4）有效生烃灶分布和“断运梁聚”的运聚模式，控制了富油气带的分布，形成灶户断鼻主油气带。

12. 采用氯仿沥青"A"法和有机碳热模拟生烃法，分区块估算生烃量、油和天然气资源量。潍北盆地总生烃量为17.9×10^8t，石油资源量0.87×10^8t，天然气资源量104×10^8m^3，并提出今后深化勘探七个有利区带和三种类型勘探目标。

潍北油田的发现与潍北盆地的勘探开发所取得的成果，是近40年来胜利油田的几代勘探家和科技人员努力工作的结果。我国陆上第一家股份制石油公司——胜利油田东胜精攻石油开发集团有限公司接管后，鉴于该区勘探上近年来未有进展，立项对潍北盆地进行了系统研究与评价。本书是在该项目研究成果和李晓清博士论文的基础上编写的，除署名作者外，参加研究和编写的还有伍大茂、刘和甫、熊保贤、刘志勇、李政、韩荣花等。本书共分九章，编写分工如下：前言由李晓清完成；第一章、第二章、第三章由李晓清、汪泽成完成；第四章由梁书义、丘东洲完成；第五章由郭勤涛、丘东洲完成；第六章由汪泽成、程有义完成；第七章由李晓清、汪泽成完成；第八章由汪泽成、伍大茂完成；第九章由李晓清、汪泽成完成。本书最后由李晓清、汪泽成、丘东洲统编定稿。

在项目研究和本书的编写过程中，始终得到了胜利油田东胜精攻石油开发集团有限公司总经理刘晓明先生的指导和支持，同时得到了胜利油田有关部门领导和专家的帮助和支持。其中有胜利油田地质科学研究院张善文副院长、宋国奇总地质师、肖焕钦副总地质师及物探公司研究中心的刘希林副总地质师。本文成文后承蒙中国地质大学刘和甫教授、中科院兰州地质所王先彬教授、石油大学周瑶琪教授和胜利石油管理局杨云岭副总地质师的审阅并提出宝贵意见。此外，刘宝珺院士在百忙中特为本书作序。在此对以上单位和个人一并表示忠心感谢。

由于走滑拉分盆地含油气性研究方法和理论日益更新，加之作者水平有限，本书中缺点与不妥之处在所难免，敬请读者批评指正。

李晓清

2003年1月

Pull Apart Basin Analysis and Its Oil&Gas—bearing Character

——take the Weibei basin as an example

Abstract

By the analysis of the Weibei Basin as an example, in the monograph this monography has systematically discussed the tectonic characteristics and evolvement, the sedimentary sequence of characteristics and evolution, as well as the reservoir characteristic and evaluation of pull apart basin. The source rocks, oil—gas source correlation and natural gas genesis have been analyzed in an all—round way, the tectonic evolution history, sequence stratigraphic framework, sedimentary model and petroleum system have been established.

The monograph is composed of preface, text (nine chapters) and illustration (xxx breadths).

Preface: natural geography location of the Weibei Basin, achievements of previous scholars and existent problems, original intention of compiling and scheme, the research design and technical route, leading issues and new understanding.

Chapter One: skip—tectonics and essential features of skip—basins

The contents include skip—tectonic features, skip—basins and their evolutions, and the features of oil and gas reservoirs of skip basin.

Features of skip—tectonics: Some topices have discussed, which include skip activities and skip faultings, plate tectonism and skip activities, the styles of skip structure and the distinguishing indications of skip structures.

Skip—basins and their evolutions: It has illustrated the skip basin types, and discussed the forming mechanisms, tectonic sequences, structural features, distinguishing indications and actual instances of pull apart basins.

Features of oil and gas reservoirs of skip basins: The typical features of oil and gas reservoirs in typical skip basis of our country and foreign countries have been briefly narrated.

Chapter Two: regional geologic setting of the Weibei Basin

This chapter focuses on discussion of the geological structural features in the Bohai Bay Basin and the Tancheng—Lujiang Fault zone and their controls on generation and growth of the Weibei Basin. Bohai Bay Basin is a large—scale Mesczoic—Cenozoic faulted basin in eastern China. Weibei Basin is a secondary structural unit of the Changwei Depression in the Bohai Bay Basin. The geological structural characteristics of Bohai Bay Basin determines the character of Weibei skip pull apart Basin and its sediment—filling features.

As a huge—scale skip fault zone in Eastern Asia, Tancheng—Lujiang Fault zone cuts across Liaoning, Shandong, Jiangsu, Anhui and Hubei, which is 1400 kilometers in length and 50—100 kilometers in width. Fault zone is consist of north section, middle section and south section. In the middle section (Weifang—Jiashan), Yishu Fault passes through Weibei Basin, which fault association in NNE direction, graben—horst pattern and skip pull apart trait directly control the formation, evolution and sediment—filling of the Weibei Basin.

On all account, the features of geological structural evolution and sediment—filling in Weibei Basin are restricted by the character of the Bohai Bay Basin, especially by the skip pull apart character of Tancheng—Lujiang Fault zone strictly.

Chapter Three: tectonic characteristic and evolution of the Weibei Basin

This chapter has expounded general condition of the strata, basement character and structure sequence, discussed the structure features of the Weibei Basin in detail, including structural framework, boundary fault and structural unit division, systemically analyzed nine kinds of basic structural styles (negative bloom, broom, listric normal fault and rollover fold, ramp—flat normal fault, listric normal fault and décollement fault—step, synthetic ridge structure, synthetic fault—step, antithetic fault—step etc.), and elaborated the features of volcanic activities such as space—time distribution, rock series, chemical compositions, and forming mechanism of volcanos. Finally it has been pointed out that the basin tectonic evolution can be divided into five stages based on the extension amount calculating and the significant basin uncomformity analyzing: the skip fault stage (K); skip fault stage (Member Ⅲ of the Kongdian Formation); the extension faulted stage (Ek2—3—Es); the skip compressive stage (Es); and the depressive and skip compressive stage (N—Q).

By analysis and domonstration of lots of data, the Weibei Basin is deemed a pull apart basin of skip extension basin type.

Chapter Four: the sedimentary sequence features and evolution of Weibei Basin

Part One: sequence stratigraphic analysis

It includes the summary of sequence stratigraphy, the analysis of seismic and drilling—logging sequence, detailed recognition of seismic reflection surface and high resolution stratigraphic division of significant drilling—logging profiles. The Kongdian Formation and the Fourth Member of Shahejie Formation can be divided into a secondary sequence, five third—class sequences and many system tracts by using sequence surface as isotime framework. The seismic facies charts of system tracts, and builted up chorostratigraphic framework model of the Weibei Basin have been worked out.

Part Two: sedimentary stystem

By seismic, boring, log, well—test, data analysis and core observation, it has been concluded that the major types of sedimentary facies in the Weibei Basin are mainly lake facies (shore—shallow lake subfacies, limnetic subfacies, semi—deep lake subfacies), fan delta facies, braided river delta facies, meandering river facies etc.. Fan delta facies and braided river delta facies can be further separated into deltaic plain, delta front and prodelta

subfacies. Every sedimentary facies and subfacies in detail have been talked over, and the sedimentary system charts by using sequence and system tracts as unit have been worked out. Some issues have been deeply discoursed upon, including the space—time distribution of LST system tracts of SQ3 sequence and LST, EST system tracts of SQ4 sequence. The genetic coupling of system tracts and tectonic attribution of basin have been talked about.

Part Three: sedimentary evolution and model

Through analyzing the features of sedimentary evolution and sediment—filling of the Weibei Basin from evolution of subsidence and sedimentary center in Kongdian Stage, the correspondence of source rocks regions and sedimentary regions, the sedimentary evolution model of Weibei pull apart basin has been established.

Chapter five: reservoir features and analysis of the Kongdian Formation in the Weibei Basin

Kongdian Formation develops three sets of favorable reservoir sequence: basalt reservoir of SQ1 sequence; sandstone reservoir of SQ3 sequence; sandstone reservoir of SQ4 sequence.

Diagenesis types in the Kongdian Formation comprise compaction and cementation and replacement. Depth of reservoir is a masterstroke of diagenetic stages, diagenetic series and pore evolvement. Secondary pores are abundant in 1700—2900 meter in depth, belonging to A period of late diagenetic stage. The concept of comprehensive diagenetic coefficient to characterize the diagenesis quantificationally has been put forward. This chapter mainly discusses the reservoir description and evaluation of the Weibei Oil Field. According to physical property parameters and phases of reservoirs, this chapter has been respectively described the variational feature of significant reservoirs (lower—middle submember of the Member I and upper submember of the Member Ⅱ of the Kongdian Formation), and evaluated and predicted highly quality reservoir.

Chapter Six: source rocks features and evaluation

The contents include distribution of source rocks, organic macerals, organic abundance, types and maturity of organic matter. In the distribution of source rocks part, five issues have mainly been discussed, including the attitude, organic component, inorganic component, forming environment and space—time distribution of four kinds source rocks including oil shale, carbonaceous shale, mark mudstone, coal bed. Organic macerals of source rocks argue the shape, attitude, optical character and their regional quantificational distribution of vitrinite, inertinite, exinite, sapropel and their subgroup. The study indicates that the more source rocks macerals in sapropel, exinite of oil shale, mark mudstone, and there are more gas—formed macerals in vitrinite, inertinite of carbonaceous shale, coal bed.

Organic abundance of source rocks: by analysis and evaluation of the space—time distribution of such parameters as organic carbon, hydrocarbon—generating potential, chloroform bitumen "A", the total hydrocarbon generation amount, it has been found that fine source rocks of the upper submember of the Member Ⅱ in the Kongdian Formation are located in northern and middle—northern basin, that moderate source rocks of the middle

submember of the Member Ⅱ in the Kongdian Formation lie in northern and southeastern basin, errand — medium source rocks of the lower submember of the Member Ⅱ in the Kongdian Formation in northern basin.

Types of organic matter: by analyzing such index as microscopic appraisal type index, kerogen, H/C ratio, pyrolysed hydrocarbon index (IH), kerogenδ13C(‰), it has been found that organic matter of the upper submember of the Member Ⅱ in the Kongdian Formation have good organic type and dominated by Ⅱ 1 type over the northern and southeastern of the basin which form the main source rocks, that Ⅱ 2— Ⅲ 2 tpye of the upper — middle submember of the Member Ⅱ of the Kongdian Formation dominate over the northern of the basin which form the main gas source rocks, that Ⅱ 2— Ⅲ 2 type of the upper — middle submember of the Member Ⅱ of the Kongdian Formation dominate over the southeastern of the basin which can form both oil source rocks and gas source rocks.

Maturity of organic matter of source rocks: by the evaluation of the organic matter of source rocks using vitrinite reflectance (Ro) and thermal peak temperature (Tmax), it has been concluded that the major areas in basin have reached mature oil—generating threshold. In particular, the northern area have both possessed the condition of generating oil, and entered peak stage of generating gas in the lower—middle submember of the Member Ⅱ of the Kongdian Formation.

Chapter Seven: petroleum system of the Weibei Basin

In the first place , the concept and research method of petroleum system has been summarized. Then the static factor and the forming process of petroleum system in the Weibei Basin has been described and analyzed respectively.

Static description of petroleum system includes source rocks, reservoir features and source — reservoir — seal combination. The study indicates that there are three source — reservoir—seal combinations in the Weibei basin: 1. top source—bottom reservoir (source: the lower submember of the Member Ⅱ of the Kongdian Formation, reservoir: the Member Ⅲ of the Kongdian Formation), its oil—gas perspective depends on reservoir capability of basalt; 2. itself source—itself reservoir (source: the lower submember of the member Ⅱ of the Kongdian Formation, reservoir: the middle submember of the member Ⅱ of the Kongdian Formation, seal: the upper submember of the member Ⅱ of the Kongdian Formation) is known as an optimal source—reservoil—seal combination up to now; 3. top reservoir—bottom source (source: the Member Ⅱ of the Kongdian Formation, reservoir: the lower submember of the Member Ⅰ of the Kongdian Formation, seal: the upper submember of the Member Ⅰ of the Kongdian Formation) is one kind of important source—reservoil—seal combination in the basin.

Analysis of forming process of petroleum system: the system simulation study on thermal evolution of source rocks has been emphasized. From typical simulation result of individual well, we can find that different well has different thermal history, this is due to they have specific tectonic setting and depth. Among them, in Yang No. 5 well, Chang No. 61 well, the Member Ⅱ of the Kongdian Formation in northern basin have high maturity and

have been entered hydrocarbon—generating peak. In Chang No. 52 well, the Member Ⅱ of the Kongdian Formation in the central basin has medium maturity. Chang No. 32 well and Tuan No. 4 well in the southern basin, have low maturity. According to thermal evolution of source rocks, it has been thought that the critical period when the reservoirs form is from Shahejie Stage to nowadays, and the Member Ⅱ of the Kongdian Formation are source rocks of petroleum system.

There are three kinds of migration paths as follwos: sandstone, fault and uncomformity. The petroleum system whose source rocks is the Member Ⅱ of the Kongdian Formation distributes mainly in northern sag and mid—northern Zaohu nose structure zone in plane.

Chapter Eight: oil—gas source correlation and natural gas genesis

By analyzing physical property of crude oil and its geochemical characteristics such as tribe component, saturated hydrocarbon chromatography, maturity, biological marker, it has been considered that the crude oil of the Weibei Basin mainly belongs to type I type mainly. The crude oil from the north ripe region belongs to typical type I , namely, immature oil formed by limnetic sapropel organic matter. The crude oil from the southeast mature region belongs to between type I and Ⅱ , which parent materials come from limnetic —fresh lake.

According to organic componentδ13C(‰) of natural gas, attitude and buried feature, the natural gas in the Weibei Basin can be distributed into six type of genesis, namely bacterial gas (biogas), bacterial—mature petroliferous gas, immature coal—petroliferous gas, mature petroliferous—coal gas, coal—formed gas, geotherm gas (gas of water and temperature). A assumption is drawn out that reckon most gas reservoir are formed in near source areas.

Chapter Nine: the hydrocarbon accumulation laws of the Weibei Basin

Embarking on known oil—gas field or pool of Zaohu nose structure zone, Liutuan shallow gas reservoir, it has been discovered that the hydrocarbon accumulation laws of the Weibei Basin is as follows: 1. Skip — extension activity controls the evolvement of sedimentary system, makes for symbiosis of oil—formed and gas—formed parent material, and makes the Weibei Basin enrich both oil and gas. 2. The fan bodies accreted with main fault provide favorable reservoir space for lithological oil—gas reservoirs. 3. Coexistence of extension and compression stress field shapes many types of traps. 4. Distribution of available hydrocarbon — generating kitchen and migration and accumulation model of "migrating along fault and accumulating under ridge" controls distribution of rich oil—gas zones, which forms main Zaohu fault—nose oil—gas zones。

内 容 简 介

本书以潍北盆地为例系统论述了拉分盆地的构造、沉积层序特征与演化及储层特征与评价，全面分析了潍北盆地烃源岩地化特征、油气源对比及天然气成因，建立了盆地的含油气系统。本书重点突出拉分盆地的构造、沉积分析与含油气性，提出潍北盆地性质属于拉分盆地，并将其划分为五个构造演化阶段；系统划分了孔店组层序地层与沉积体系，建立了层序地层格架与沉积模式；分析了含油气系统油气成藏的静态要素和动态过程；将天然气成因分为细菌气、细菌-成熟油型气、低熟煤型-油型气、成熟油型-煤型气和高熟煤型气五种类型；总结了潍北盆地油气富集规律，指出了深化勘探的方向。

本书基础资料丰富、内容全面翔实、图文并茂，将拉分盆地构造、沉积与含油气性分析融为一体，具有较高的理论水平和应用价值；可供从事构造地质学、沉积地质学、地震地层学、地球化学、石油地质学及含油气盆地分析研究人员和大专院校师生参考。

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