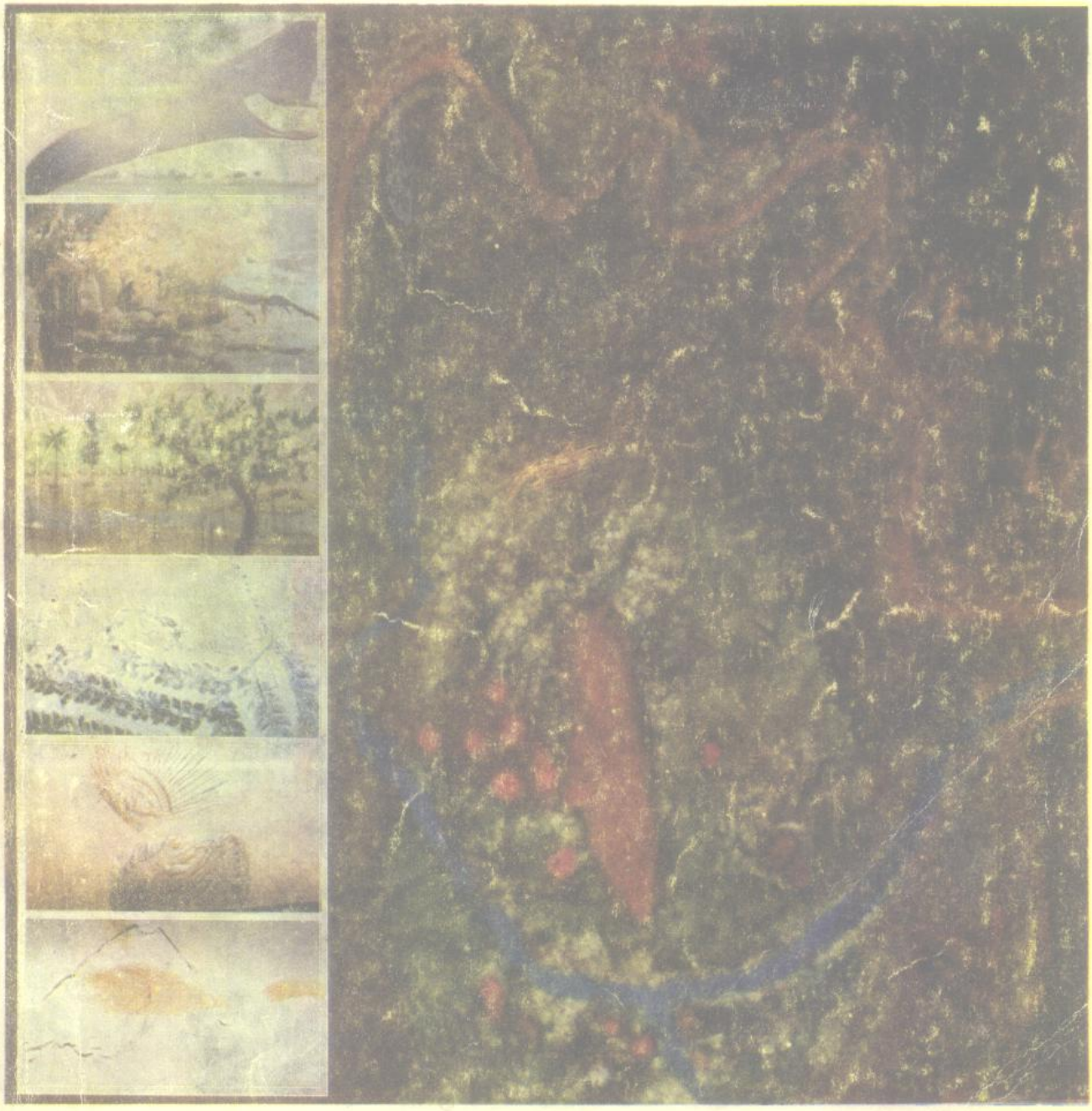
主编 杨万里

松辽陆相盆地石油地质

石油工业出版社



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序

松辽盆地中的大庆油田，是我国目前发现的最大油田，也是当今世界上陆相沉积盆地中发现的特大油田。它的发现引起了国内外石油地质专家和学者的关注。它的勘探和开发对于我国石油工业的发展和世界石油地质科学的进步起了重要作用。为了纪念大庆油田开发二十五周年，加强石油地质科学的学术交流，运用石油地质科学的进步促进石油勘探的发展，特编辑出版了这本《松辽陆相盆地石油地质》。

(一)

松辽盆地位于我国东北，地跨辽宁、吉林、黑龙江及内蒙古自治区，面积约26万平方公里。松辽盆地石油勘探始于五十年代初期。东北地质局在盆地边缘及东部地区进行了地质普查和浅井钻探。1956年3月起，石油部和地质部在盆地整体部署了石油地质勘探工作。为了迅速查明盆地地质概况，针对松辽盆地这样一个被广泛第四系沉积覆盖的大平原，采取全面部署，多工种(航空磁测、重力、磁力、电法、地震、地质调查、浅钻、深探井等)协同综合勘探方法，很快建立了地层层序，明确了白垩系是盆地主要的生储油岩系，中央坳陷区是含油最有利地区，并发现了一批可供钻探的潜伏构造。

1958年4月，地质部浅钻队在吉林省境内前郭旗附近的南17孔，首次钻到含油砂岩，虽未获得工业油流，但证实了松辽盆地具有生油储油远景。与此同时，石油部组建了松辽石油勘探局，派出五个详查队和两个专题研究队，投入20个重磁力及地震队，两部大型钻机，对盆地东北进行了地质详查，对盆地东部进行重磁力详查和深井钻探。经过一号和二号基准井的钻探和在已有资料综合分析的基础上，1959年春开钻了大庆长垣高台子构造上的松基三井。在国庆十周年前夕，即1959年9月26日，在该井深1357.0～1382.5米高台子油层，喷出原油，这是松辽盆地勘探中获工业价值油流的第一口探井。为了纪念建国十周年这个大喜大庆的日子，取名为大庆油田。从此，揭开了松辽盆地大规模勘探的序幕。

1960～1970年，在勘探部署上，应用背斜理论，从大庆长垣——二级构造带整体出发，部署了大庆油田第一批探井，甩开钻探，仅用了一年零三个月的时间，探明大庆长垣具有统一的油水界面，七个局部构造全都含油；初步拿下了油田地质储量，确认大庆油田是我国的第一个大油田。与此同时，在油田的外围地区，北起克山，南至长岭，西达富拉尔基，东到三肇、朝阳沟等地区，大面积地进行了地震普查和深井钻探，并对已发现的主要局部构造都进行了钻探，发现了一批中小型背斜油田和工业油气流井。

1970～1983年，为扩大找油领域，寻找新的后备储量，对已有的资料进行了认真地综合分析研究。特别是在我国东部其他盆地的断块油田的发现，及岩性地层、古潜山圈闭油藏的勘探和开发，为松辽盆地勘探提供了新的认识，受到很多启发。1973年再次钻探泰康连环湖地区，1975年后，又在滨洲线以北超覆带和三肇、古龙地区进行了多种类型的油藏勘探，发现了三肇大面积的岩性油藏。1978年以后，勘探工作进一步活跃，发现了新店—敖古拉断裂封闭的油气藏带；找到了浊积砂、泥岩裂缝储油层；在岩基风化壳及深部侏罗系地层中，获

得了新的成果，为勘探复杂的隐蔽油藏提供了丰富的资料。接着对黑龙江省境内10个大于1000平方公里的新生代沉积盆地进行了资料调查；在盆地外围的三江、二连、依兰—伊通、海拉尔等盆地进行了地面地质调查，并钻了一些参数井，勘探工作量大幅度上升。特别是1981年提出对松辽盆地进行二次勘探以后，又发现了一些新的含油地区，扩大了地质储量，发展了地震地层学。目前，松辽盆地的勘探，已进入寻找多生油层系、多种储集岩体、多种圈闭类型的新阶段。

（二）

松辽陆相盆地石油地质研究，有一个不断发展的过程，随着研究水平的不断提高和手段的不断改进，对一些地质问题的认识也在不断的提高和深化。五十年代初期，我国地质学家和一些科研单位，对陆相地层生油问题进行了许多研究，并提出了不少看法，随着大庆和华北等地一批油田的陆续发现，为陆相石油地质研究，提供了重要内容，为石油地质科学的发展增添了新的篇章。

陆相地层沉积研究取得了较大的进展。在大庆油田发现之后，对盆地地层沉积性质的认识，成为石油地质研究的主要课题之一。二十多年来，通过几万个样品的分析，先后应用40多项指标，从六个方面对盆地地层沉积进行了全面系统的研究和论证，并确立了松辽盆地白垩系为陆相沉积性质。其依据是：盆地微体古生物和大古生物，大都生活在淡水中，只有少数种属生活在微咸水中，表明为淡水—微咸水的沉积环境；地层中氯化盐含量及微量元素资料，反映盆地为典型的陆相地层沉积特征；在研究泰康地区白垩系鲕状灰岩时，发现的海绿石，经过多种化验手段和化学全分析得出，泰康海绿石在结构上属于无序非膨胀性云母型晶格海绿石，成份上具有高铝、低钾、低铁的特点，与典型海相海绿石不同，而与国外非海相地层中发现的海绿石相似。

陆相湖盆沉积及相模式研究方面，也做了大量工作。河流湖泊相沉积，有它自己的特点。松辽陆相湖盆沉积速度和沉降速度频繁交替变化，反映在平面上湖进湖退的涨缩，形成了垂向上的多套含油组合，造成了储油的各种有利空间。湖盆中心部位沉积很厚的暗色泥岩，成为高效生油岩体，与其周围有利的构造、岩性、断层等各种圈闭有机配合，形成工业油气藏。通过大量实际资料的分析对比，比较系统地建立了松辽盆地河湖沉积的七种大相14种亚相类型，即洪积相、泛滥平原相、分流平原相、三角洲相、滨浅湖相、较深-深湖相和平原淤泥相，建立了河流三角洲沉积模式，确立了不同相区的各种砂体形态，总结了多方向、多物源、多沉积体系和环带状沉积特征。明显区别于海相的陆相沉积，岩性变化大，油藏类型多而复杂，为形成隐蔽油气藏提供了极好的场所。

陆相油气生成和演化模式的研究是近代科学研究中的新课题。我国许多著名地质学家为之奋斗了近半个世纪。松辽盆地二十四年的科学研究与实践，提供了大量新资料，提出了区别于前人的一些概念和见解，丰富和发展了这门学科。如，提出陆相油气形成的最佳条件，即大型富营养湖泊，快速湖进式非补偿沉积长期存在的继承性深水凹陷，高地温场的聚热效应，是陆相生油的最好环境；大型湖盆有机质分布和演化模式，它的特点是Ⅰ、Ⅱ、Ⅲ类干酪根呈环带状分布，从湖心向湖岸有规律的递变；根据陆相生油母质（干酪根）类型可以转化的概念，建立了迭合腐泥型干酪根成油模式；迭合腐泥型干酪根，主要来源是淡水藻类和高等植物经过强烈细菌改造，转化为高效生油母质，其生烃特点是成熟早，生油潜力大，排烃效

率高。同时还建立了陆相油气初次运移时空模式等。这些研究成果，为石油勘探和资源的预测，提供了科学依据，为石油地球化学的应用开辟了广阔的前景。

陆相大油田形成模式的研究，是对油气生成、排出、运移、聚集认识上的一个深化过程。对这一个过程的认识是否有科学性，将是一个十分重要的问题。大量的生产实践与科学研究得出，陆相大油田形成的基本地质规律，是“五体复合匹配，五期同步演化”。具体地说，就是在大油田形成的过程中，生、储、输、圈、盖等五种地质体在空间组合上的复合匹配；生油、排油、油气运移、油气聚集与构造生长等五个时期的同步演化，是陆相大油田形成的关键。众多的油气藏形成研究表明，油气生、排、运、聚时期与构造生长时期的超前—同步—随后之演化关系，直接控制着各类油气藏的形成。如果生油、排油、运移、聚集与构造同步发展，可形成大油气田；构造的超前或随后，将形成类型不同和规模不等的油气田；构造随后，甚至不可能形成油气田。因此，油气田的形成主要决定于各种地质因素在空间上的组合和时间上的演化关系。

(三)

收入本论文集的文章，是松辽盆地石油地质研究的主要成果，也是松辽盆地不同勘探阶段的石油地质研究的代表作；虽然绝大部分是在国内外有关学术刊物上公开发表过的，但不少的文章具有一定的学术水平和理论价值，曾对松辽盆地石油勘探起过重要的指导作用，因此，把这些文章汇成专题论文集是有意义的。

本论文集按陆相石油地质总论、陆相地层沉积性质、陆相生油环境、陆相石油形成及演陆化、相大油田形成、陆相油气藏分布等六个方面编辑而成。书中提出的许多石油地质方面的基本认识，目前尚有不同的看法。本着“百家争鸣、百花齐放”方针，通过共同探讨，以促进我国石油地质科学的不断发展。

由于编辑的水平有限，书中难免有不妥之处，请读者指正。

参加本书编辑和工作的有：高瑞祺、许文治、陈月艳和张家茂、任积文、叶德泉、刘民中、杜智文、沈铮等同志，以及大庆石油管理局勘探开发研究院制图室和情报室大力帮助，一并表示谢意。

杨万里

一九八四年六月

PREFACE

Daqing oil field in Songliao basin is the largest field discovered in China and one of the giant oil fields so far found in continental basins of the world. Its discovery has greatly attracted petroleum geologists and experts at home and abroad, and its exploration and development has made a significant contribution to the growth of China's petroleum industry and the development of petroleum geology of the world. In order to celebrate the 25th anniversory of the development of Daqing oilfield, promote academic exchanges in petroleum geology and use the progress made in petroleum geology to advance petroleum exploration, the «Monograph on Continental Petroleum Geology in Songliao Basin» is specifically edited and published.

Located in Northeast of China, Songliao basin covers Liaoning, Jilin and Heilongjiang provinces as well as Nei Monggol Autonomous Region, with an area being about 260,000 square kilometers.

Petroleum exploration in this basin began in early 1950s. At that time, the Northeastern Geological Bureau conducted a geological reconnaissance survey and shallow exploratory drilling at the edge and in the eastern part of the basin. From March 1956, Ministry of Petroleum Industry and Ministry of Geology carried out the overall petroleum geological prospecting plan in the basin. In order to ascertain rapidly the geological setting of the basin covered by broad Quaternary sediments, an overall planning and a coorporative integrated exploration method (including airborne magnetic, gravimetric, magenetic, electric, seismic and geological survey as well as shallow and deep exploratory drillings, etc.) were adopted, resulting in a quick establishment of formation sequence. In light of this, it was very soon recongnized the Cretaceous system was the primary source reservoir rocks and the central depression of the basin was the most favourable oil-bearing area. Consequently, a lot of commercial burried structures were found.

In April 1958, the shallow drilling team of the Ministry of Geology drilled the hole South 17 near Qianguo Banner of Jilin Province, which encountered the oil-bearing sandstone firstly. Although no commercial oil was obtained, but it confirmed that Songliao basin had the potential of oil generation and accumulation. Meanwhile, the Ministry of Petroleum Industry set up the Songliao Petroleum Exploration Bureau, sent 5 detailed survey teams, two professional study teams and 20 gravimetric and magnetic crews and assigned 2 giant drilling rigs to carry out detailed geological survey in the northeastern part of the basin and gravimitric and magnetic surveys and deep exploratory drilling in its eastern part.

After drilling the first and second key wells and on the basis of composite analysis of the existing data, in Spring of 1959, the third Songliao key well was spudded on the Gaotaizi structure of the Daqing Placanticline, which gushed crude oil from Gaotaizi reservoir at the depth of 1357-1382.5 meters on Sept. 26, 1959, just before the 10th anniversory of the founding of the People's Republic of China. It is the first commercial oil well drilled in Songliao Basin. In memory of this great date the oil field discovered was named Daqing, which means great celebration. From then on, a curtain on the large-scale exploration in Songliao basin was raised.

Form 1960 to 1970, in accordance with the anticlinal theory, the first exploratory wells of the field were drilled, taking the second-order structural belt, Daqing placanticline as a whole. With spreading-out type drilling, only in a period of one and a quarter years, seven local oil-bearing structures with a common oil-water contact in the placanticline were all verified, and the OOIP of the field was preliminarily proven. It was confirmed that Daqing oil field is the first giant oil field of our country. At the same time, in the peripheral areas of the field, which extend to Keshan county in the north, Changling county in the south, Fularji city in the west and Sanzhao and Chaoyanggou region in the east, a broad seismic survey and deep exploratory drilling were conducted and exploratory drilling in principal local structures discovered as well, finding out a lot of middle-small anticlinal oil fields and commercial oil and gas wells.

From 1970 to 1983, in order to expand the realm of petroleum exploration and to find out continuously some new oil reserves, the existing data were carefully and comprehensively analyzed. Meanwhile, the discovery of the fault-block oilfields and the exploration and development of litho-stratigraphic and burried hill oil traps in the other basins of East China gave us new guidance and greatly inspired us in the prospecting for petroleum in Songliao basin. In 1973, a re-explor-atory drilling was made in Lianhuanlake region of Taikang county, and after 1975, the exploratory activities to find multiple kinds of oil pools in the overlap belt lying the north of Harbin-Manzhouli railway and in the Sanzhao-Gulong region were undertaken, resulting in the discovery of broad lithologic pools in Sanzhao region. Since 1978, petroleum exploration has been more active in this basin, some new findings, such as Xindian-Augula faulted petroleum pool belt, turbitite sandstone and fractured shale reservoirs and those oil traps in weathered base rocks and the Jurassic deep formation have been obtained, providing sufficient information to searching for complecated subtle traps. In addition, geological data on other ten Cenozoic sedimentary basins greater than 1,000 square kilometers in area, respectively, in Heilongjiang province were collected, surface geological survey and driling some key wells in the peripheral basins such as Sanjiang, Erlian, Yilan-Yitong and Hailar were conducted. Particularly, after the

re-exploration in Songliao basin began in 1981, some new oil-bearing areas there were discovered, OOIP of the basin enlarged and the seismic stratigraphy advanced. At present, the exploration for petroleum in Songliao basin has entered a new stage of searching for multiple source rock system, multiple reservoirs and multiple types of traps.

The study of petroleum geology on Songliao continental basin underwent a process of progressive development. With the continuous improvement of reserch means, our understanding on certain geological problems has been gradually deepened. Since early 1950s, some geologists and scientific research units in our country have made many studies on the generation of petroleum in continental formations and put forward a number of new views on it. The continuous discoveries of a lot of oil fields such as Daqing and those in North China and other regions provide important fresh material for the study of continental petroleum geology and added some new chapters to the development of petrolenm geology. A great progress has been made in the study of deposition of continental formations. After the discovery of Daqing oil field, the understanding of depositional features of the formations of the basin became one of the principle research topics. Over the past more than 20 years, more than 40 indices from analyses of several dozen thousand samples have been used to systimatically study and prove the sedimentary characteristics of the formations of the basin in six aspects, establishing the properties of the continental formations of the basin. What we are based on are: the comparisons in micro-paleontology and macro-paleontology, which indicates that most of the organisms lived in fresh water and only few species or genus of them lived in brackish water, showing the fresh water-brackish warer depositional environment, the chloride and the trace element contents of the formations, which reflect this depositional characteristics of typical continental formation; the glauconite found in Cretaceous oolitic limestone in Taikang region, which underwent many kinds of chemical examinations and whole chemical analysis, indicating that the Taikang glauconite is of non-sequential, non-swelling mica-like crystal type in texture, and rich in aluminium and poor in potassium and iron, different from typical marine glauconite, tut similar to those formed in nonmarine sediments in the other countries.

A lot of job has also been done for the study of deposition and facies model of continental lake basin. Fluvial-lacustrine deposits have their own sedimentary charaters. The frequent alternation of deposition rate and subsiding rate in Songliao continental lake basin, reflected by multiple accurrences of lake transgression and regression, created multiple sets of oil-bearing assemblages and formed various spaces favourable for oil storage. The very thick dark mudstone, deposited in the central part of the basin, became the highly effcetive source rocks and its organic coordination with strnctural, lithologrc and fault traps in the periphary

of the depression formed commercral oil and gas pools. The continental deposits which are obviously different from the marine ones provided very good places for the formation of subtle traps due to their great changes in lithology and to the variable and complicated oil and gas pools.

Study of generation and evolution model of continental hydrocarbon is a new topic in current scientific research for petroleum, for this, many famous geologists of China have fought 50 years of their life. Scientific research for and practices in Songliao basin conducted over the past 24 years have provided a numer of new data, advanced some new concepts and views from those raised by our predecessors and enriched and developed the petroleum science. For instance, it is considered that a large eutrophic lake, a long time continuous sudsiding deep structural sag, a rapid lake-transgressive non-compesatory deposition and the effect of heat accumulation in high geothermal field are the most favourable environments for oil generation of continental rocks. The distribution and evolution model of organisms in large lake basin is characterized by a ring-like occurrence of types I, II and III kerogen and their progressive change from lake center to lake coast. Based on the concept that the continental petroleum precursors (kerogen) can transform from one type to another, an oil generation model of combined sapropelic kerogen has been set up. This type of kerogen was mainly dirived from fresh water algae and the strognly bacteriareworked higher plants. It is a kerogen of early maturation and of high efficiency for oil generation and expulsion. In addition, a time-spatial model for primary migration of continental hydrocarbon was built up as well. All these results of study have provided a scientific basis for petroleum exploration and resources prediction and opened a vast vistas for the application of petroleum geochemistry.

Study on the formation model of a giant continental oil field, is a process of gradually deepening the understanding of hydrocarbon generation, expulsion, migration and accumulation. Wheather this process can be understood scientifically or not is a very important problem A great number of production practices and scientific researches give out a basic rule of"cloes coordination of five bodies and synchronistic evolution of five stages"to the formation of a giant continental oil field, which is, in the concrete, the close coordination of the spatial assemblage of source rock, reservoir rock, carry bed, trap and cap rock during the formation of the giant oil field. The synchronistic evolution of stages of hydrocorbon generation, expulsion, migration and accumulation with the growth stage of structure was the key point to the formation of the giant continental oil field. A number of studies on the formation of hydrocarbon pools indicate that the lead-synchronization-follow up evolution relationship of stages of hydrocarbon generation, expulsion, migration and accumulation with the growth stage of structure directly controlled the formation of all kinds of petroleum pools. If the synchronistic development of

stages of hydrocarbon generation, expulsion, migration and accumulation with the growth stage of the structure could form giant oil or gas fields; lead or follow-up of the structure would form various types and different sizes of field; sometimes the follow-up of sturcture even could not form any oil or gas fields. Thus the formation of oil and gas fields primaryly depens on the spatial combination and time evolution of various geological foctors.

Papers involved in this monograph reflect the principal results of study on petroleum geology basin and are the representative works of studies made in various exploration stages of the basin on petroleum geology. Although most of them have been openly published in relevant academic journals of China, a few do have considerable theoretical value, reach a academic level and have plaid a guiding role in the exploration for petroleum in Songliao basin, so the publication of this monograph consisting these papers is of great significance.

This monograph was edited in the order of general views on continental petroleum geology in Songliao basin, continental stratigraphic division and correlation, environment for oil generation of continental rocks, formation and evolution of continental hydrocarbon, formation of a giant continental oil field, and distribution of continental oil and gas pools. It is believed that some different views on many basic concepts presented in the book still exist. Adhering to the principle of "letting a hundred flowers blossom and a hundred schools of thought contend different views", we hope that common discussions will bring about a continuous advance of China's petroleum geology.

Being limited in technical level, the editor will appreciate the readers for giving their valuable comments and opinions.

I acknowledge all those who have given their close corporation in editing the book: Gao Ruiqi, Xu Wenzhi, Chen Yueyian, Zhang Jiamao, Ren Jiwen, Ye Dequan, Liu Minzhong, Du Zhiwen, and Shen Zheng et al, and all the comrades in Cartographic Department and Petroleum Information Research Center of the Research Institute of Petroleum Exploration and Development of Daqing Petroleum Administrative Bureau, who gave me much help in editing this book.

Yang Wanli

June 1984
Daqing, China

President of Society of Petroleum Geologists of Heilongjiang Province, Senior Geological Engineer

目　　录

一、陆相石油地质特征与油气勘探

松辽盆地油气分布基本规律及勘探远景预测

杨 万 里

摘要 本文从沉积盆地类型、古湖泊性质、沉积特点、地温场和地层水动力条件等方面，分析了松辽盆地石油地质特征，对陆相油气生成、排出、运移和聚集规律作了论述。阐明了大型湖盆的油气分布模式，并根据资源量的预测和油气分布的基本规律，对松辽盆地北部的勘探前景进行了论证，预测了有利的勘探地区。

松辽盆地陆相生油形成特大油田，引起了国内外石油地质家们的普遍重视。大量的勘探实践与理论研究表明，松辽陆相沉积盆地之所以能够形成象海相盆地那样的特大油田，主要是因为它所具有的特定的地质背景，以及油气生成、排出、运移、聚集等必要的有利条件，构成了良好的"复合匹配"关系。同时，油气的生成期、排出期、运移期和聚集期与构造生长期的超前—同步—随后的发展，也有着比较理想的配合关系。因此，认真总结松辽盆地的石油地质基本特征，探讨油气生成、排出、运移聚集的规律，分析油气藏的形成类型和建立油气分布模式，对发展石油地质理论和指导油气勘探实践，都具有重要的意义。

本文应用了大庆科学研究设计院的一些资料，并得到了该院有关同志的支持和帮助，在此一并致谢。

一、松辽盆地石油地质基本特征

松辽盆地为一北北东向的菱形盆地，面积约26万平方公里。盆地基底为古生代和前古生代变质岩系，属于天山-兴安岭华力西褶皱带的一部分；由三个复背斜和二个复向斜组成。

盆地的沉积盖层主要由侏罗系、白垩系、上下第三系和第四系组成，最大厚度达万米，白垩系是盆地中最主要的沉积岩系，厚度大，分布广。有八个含油层，按生、储、盖的组合关系，划分为浅部、上部、中部、下部和深部等五套含油组合(图1)。

根据地震资料做出的构造图分析，深层(泉二段以下)和中浅层的构造面貌有较大的差别，前者的基本面貌为："一隆两坳"即在盆地中部有一个古中央隆起带，其东部和西部有两个裂陷；后者的基本面貌为平缓的褶皱，凹隆相间，二级构造成带状分布，大断裂较少，小断裂比较发育(图2)。

1. 盆地类型

盆地类型的划分及对比，既是一个理论问题，也是一个实践的重要问题。近年来一些地质人员按照板块构造理论，将松辽盆地盆地类型作过划分(表1)。

松辽盆地位于亚洲东部上地幔隆起的中段，地幔隆起的最高处为29公里，莫霍面以33公

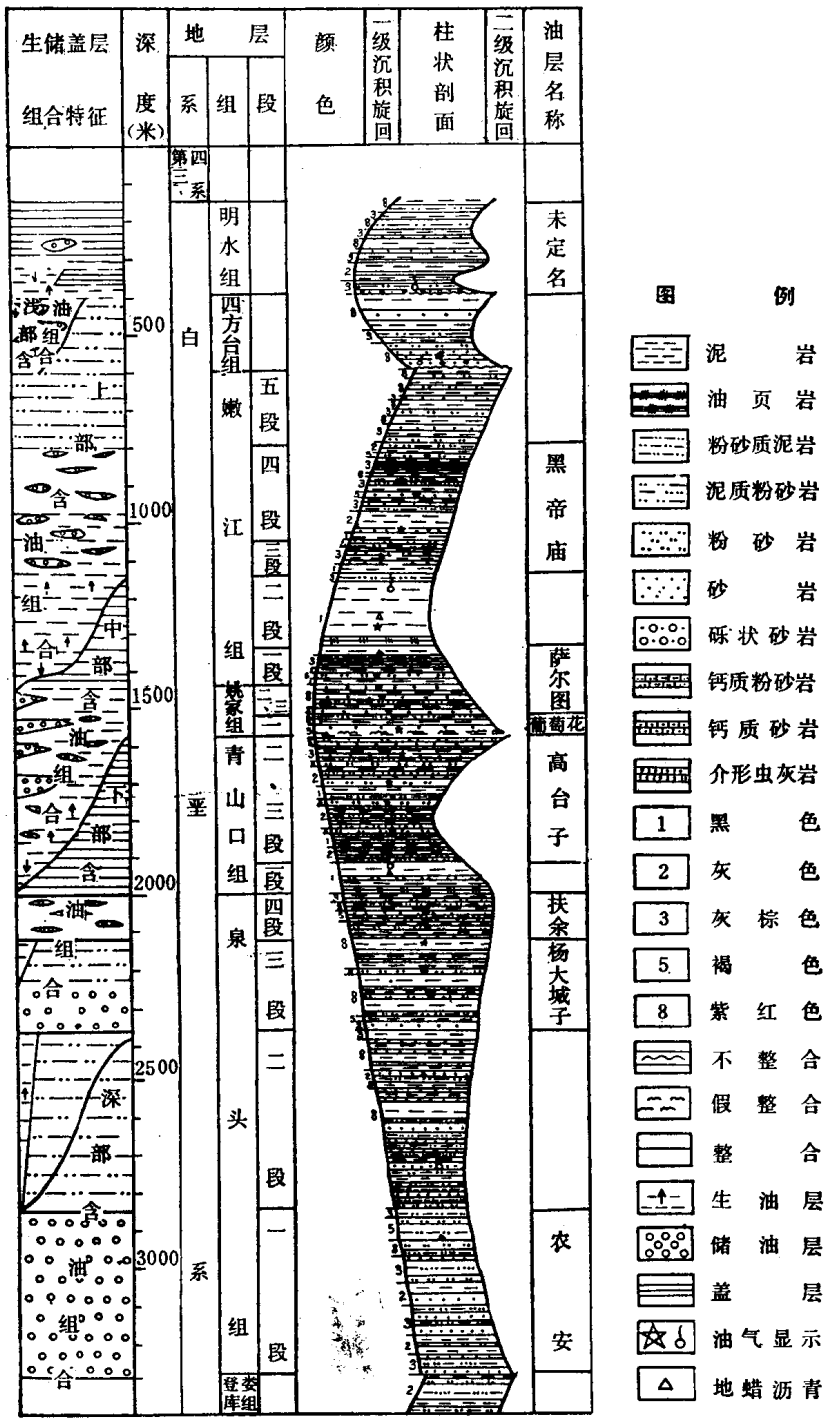

图 1　松辽盆地的白垩系含油组合柱状图

里等深线闭合，大体上与盆地的现今边界吻合，盆地现今边界附近仍有地壳断裂的分布（图3）。

松辽盆地的演化与亚洲大陆的初始张裂和太平洋板块的俯冲有关，具有裂、压两重性，就其特征和成因讲，属克拉通内复合盆地，与北海盆地、西西伯利亚盆地有许多相似之处。主要表现在：盆地内部有一个隐蔽的地堑存在，裂谷的形态或莫霍面隆起的形态呈三联式，

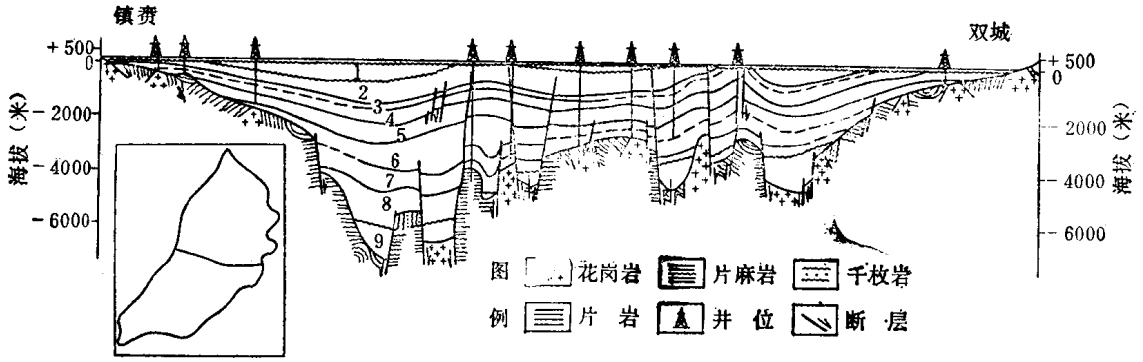

图 2　松辽盆地镇赉—双城构造横剖面图

1—明水组、四方台组；　2—嫩江组；　3—姚家组；
4—青山口组；　5—泉头组三、四段；　6—泉头组一、二段；
7—登娄库组三、四段；　8—登娄库组一、二段；　9—侏罗系

表1　松辽盆地盆地类型划分意见表

杨万里等 (1980)	H.D克莱米 (1980)	张恺等 (1981)	杨祖序等* (1983)	高名修等* (1979)
克拉通内复合盆地	克拉通内裂谷盆地	双岩浆弧后裂谷盆地	弧后裂谷盆地	弧后盆地

*(1)杨祖序等："松辽盆地演化与油气分布特点"；

(2)高名修："中国东部晚中生代—早新生代盆地系的地球动力学模式"。

盆地都具有先断后坳的双层结构；高地温场；盆地造山运动不强；盆地为对称的，后期演变为大面积的坳陷式盆地。

据H·D克莱米盆地分类，所属克拉通内复合盆地的油气储量较大（总储量占世界盆地含油气储量的四分之一），并且在此类盆地中常存在着大型隆起或大型穹窿，有50%的储量集中在这类构造中形成一个大油田。松辽盆地形成象大庆油田这样的特大油田，从其盆地类型分析认为主要是因为：克拉通内盆地的快速大面积整体下沉；盆地中央存在一个长期继承性的构造深凹陷，而这个深凹陷与莫霍面隆起，裂谷形成和地壳深断裂有密切的成因关系。

2. 古湖泊性质

松辽湖盆是白垩纪亚洲古陆上最大的湖盆地，约有4～6个内陆水系流入湖中，湖水最大覆盖面积曾超出了20万平方公里(表2)并经历了多次涨缩(图4)。松辽盆地属于近海构造外流盆地，白垩纪湖泊的出口处大约在今宾县地堑附近。

依据古生物和地球化学资料分析，松辽盆地古湖泊的水介质为淡水-微咸水，其含盐度大体为0.5～5‰属于少盐水，但在古龙凹陷和三肇凹陷等深水生油区，含盐度稍高为5.0～‰10属于中盐水较淡的性质。

白垩纪时期，松辽湖泊属于富营养湖泊，丰富的淡水藻类生物体为生油母质提供了充足的来源。并且由于古湖泊中有着大面积的无氧带，使沉积物中的丰富有机质得以保存。

3. 沉积特征

沉积条件是油气生成和大油田形成的重要因素。松辽陆相沉积盆地石油的生成和大油田的形成，主要具备了如下的沉积条件：(1)形成大面积有利生油层的沉积环境；(2)形成比

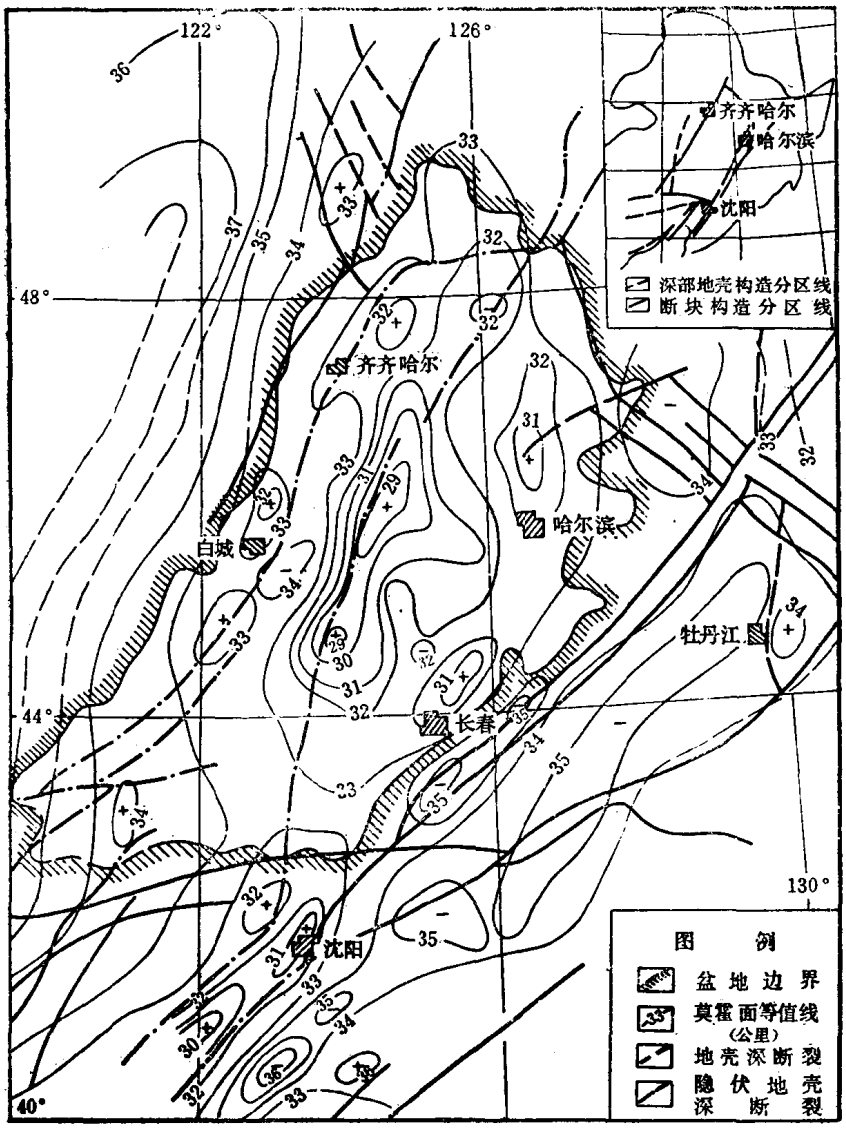

图 3　松辽盆地莫霍面深度及地壳断裂分布图

表2　白垩纪各时期松辽盆地湖泊大小及内陆水系发育情况表

时　　期	湖水面积 (万平方公里)	内陆主要水系(个)
泉三段沉积时期	沼　泽	6
泉四段沉积时期	0.4～0.5	6
青一段沉积时期	8.7	5
青二、三段沉积时期	3.5～6.8	4
姚一段沉积时期	1.0	4
嫩一段沉积时期	大于 10	2～4
嫩二段沉积时期	大于 20	2～4

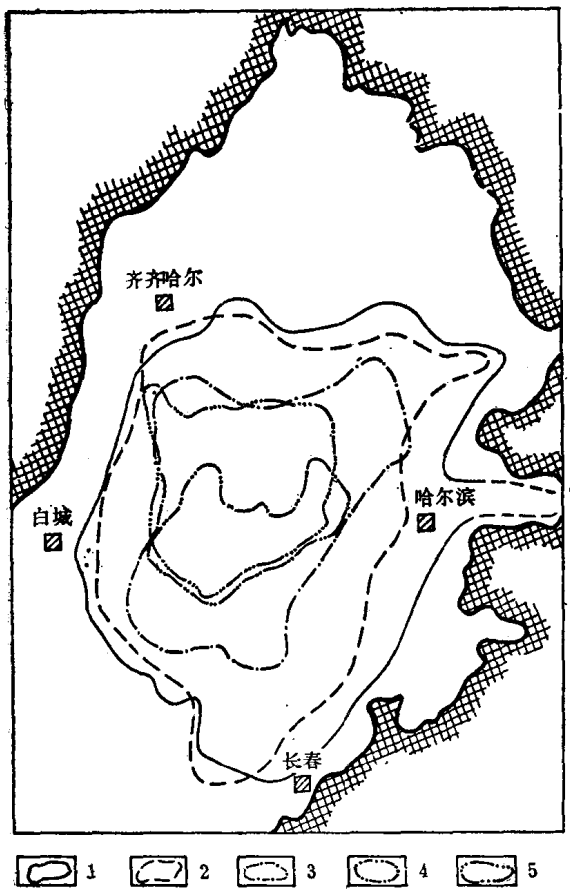

图 4　松辽盆地白垩纪古湖泊变迁图

1—青一段湖岸线；
2—青二、三段早期湖岸线；
3—青二、三段晚期湖岸线；
4—姚二、三段湖岸线；
5—姚一段湖岸线

状和断续状砂、三角洲前缘透镜砂及零散砂（表 3）。

较理想的生、储、盖组合的沉积条件；（3）形成区域性大盖层的沉积条件；（4）形成大砂岩体的沉积条件。

松辽盆地在其发展过程中，具有沉降与补偿的相对均衡与不均衡的盆地先成特征与盆地同生特征。盆地先成期形成大面积的未被波浪分选和破坏的快速湖进式非补偿沉积；此种沉积有机质含量丰富，是良好的生油层，同时又是区域性的封闭盖层。盆地同生期形成的补偿沉积，纵向上泥砂岩交互，与先成期沉积构成理想的生、储、盖组合，形成了多套含油层系。

松辽盆地储集层以砂岩为主，储集大量油气与三角洲砂体的存在有密切的关系，按成因形态划分，主要有两种类型的三角洲复合体。

（1）源远流长的河流形成的叶状三角洲复合体（图 5）。它的特点是：分布面积大，过渡相带宽，由多种砂体组成。如中部含油组合的北部三角洲复合体，延伸长度达200多公里，分布面积为20000平方公里，砂岩体体积为2000立方公里。聚油的部位包括曲流河的下游厚层条带砂、曲流河下游及分流上部条带砂、三角洲分流条

表3　北部三角洲复合体葡I_5砂体分布特征

砂体类型（自北向南）	储集体特征					可能形成圈闭类型
	单层厚（米）	粒度（毫米）	孔隙度（%）	渗透率（毫达西）	孔喉半径（微米）	
厚层条带砂	>10	0.15～0.20	>25	>400	5.2～7.4	背斜圈闭为主
条带砂	6～10	0.13～0.15	23～25	200～400	4.0～5.2	背斜-断层圈闭为主
条状及断续状砂	2～6	0.10～0.18	20～23	100～200	1.0～4.0	大面积岩性圈闭为主
透镜砂及零散砂	<2	<0.10	<20	<100	<1.0	小型岩性圈闭为主