

MAJOR NONMARINE
OILFIELDS OF CHINA

张文昭 主编

中国

陆相大油田

石油工业出版社

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内 容 提 要

本书系统总结了我国陆相大油田的石油地质理论。上篇综述,论述陆相大油田形成的地质基础、地质条件与分布规律。下篇大油田各论,对38个陆相油气田的发现史、油田地质特征和油田形成的地质背景等进行阐述。本书可供石油地质勘探专业的科研、技术人员及大专院校师生阅读。

图书在版编目(CIP)数据

我国陆相大油田/张文昭主编.

北京:石油工业出版社,1997.9

ISBN 7-5021-2114-5

I. 中…

II. 张…

III. 陆相油气田-石油天然气地质-中国

IV. P618.130.2

中国版本图书馆 CIP 数据核字(97)第
19017号

本书上中国国界线系按照中国地图出版社
1989年出版的1:400万《中华人民共和国地形
图》绘制。

石油工业出版社出版

(100011 北京安定门外安华里二区一号楼)

北京华茵文化印务咨询公司排版

北京市南方印刷厂印刷

新华书店北京发行所发行

*

787×1092毫米 16开本 66½印张 14插页 1661千字 印1—1500

1997年9月北京第1版 1997年9月北京第1次印刷

ISBN 7-5021-2114-5/TE·1778

定价:118.00元

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序

中国是发现和利用石油、天然气最早的国家之一，早在公元前一二世纪，陕北一带就发现了石油。以11世纪中国创造的“卓筒井”技术为标志，古代中国石油地质勘探曾一度处于世界领先地位。但从1878年首次采用新式机器钻凿油井到1949年的70多年间，石油工业发展缓慢，总共只钻井169口，生产原油270多万吨，中国所需油品基本靠外国进口，外国专家对中国石油资源的评价十分悲观，不乏“陆相贫油”、“中国贫油”论者。

新中国成立后，广大石油职工依靠科学、勇于实践，在艰难中起步，在探索中创业，推动石油工业不断发展壮大，50年代在西北地区先后发现了新疆克拉玛依、青海冷湖等油田，并在东北、华北、西南等地区逐步展开石油勘探。60年代初进行的大庆石油会战，是我国石油工业发展史上的重大转折。这次会战的胜利，实现了我国石油的基本自给，以发现陆相大油田的事实，打破了“中国贫油”的论断。尔后石油勘探在渤海湾地区进一步大规模展开，相继发现了胜利、大港、辽河、华北、中原等储量丰富的油田，原油产量迅速增长，1978年突破了1亿吨，从此我国进入了世界主要产油国家的行列。改革开放以来，中国石油工业进入了新的发展时期，油气勘探从陆上至海上全面展开，大量的勘探开发实践使石油地质理论水平不断提高，同时通过对外合作和勘探新技术、装备的引进，我国勘探技术和管理工作日益接近国际水平，总结了一套适合于陆相复杂油气田的勘探经验，科学技术是40多年来发展最快的时期。

经过40多年艰苦奋斗和大量的油气勘探实践，我国已在陆相盆地中发现了419个油田，其中有32个亿吨级的大油田，从我国西部天山南北的塔里木、准噶尔、吐一哈盆地，到中部的陕甘宁盆地，直至东部的松辽、渤海湾盆地和南海大陆架都有大油田分布。从盆地类型而言，不管是中、西部的前陆盆地，克拉通盆地或东部的裂谷盆地都有大油田的存在。从地质时代而言，新生界、中生界、古生界直到元古界—太古界也都发现了陆相大油田。中国陆相大油田形成与分布具有固有的规律，从油气系统理论分析大体有5种类型：（1）中央隆起型（凹中隆），如大庆油田、文留油田；（2）凸起披覆背斜型，如孤岛、孤东油田；（3）基底古潜山型，如任丘油田；（4）凹边斜坡型，如曙光—欢喜岭油田；（5）凹中岩性型大油田，如三肇凹陷榆树林、朝阳沟油田。经过近40年勘探实践、探索，已建立起一套具有中国陆相特色的石油地质理论，主要包括：

陆相生油理论，中国含油气盆地类型理论，复式油气聚集区（带）理论和煤层烃理论，以及陆相湖盆沉积体系、储层评价理论与方法等，依靠上述理论指导勘探实践不断发现大油田，使我国石油产量持续上升，1995 年年产油量达到 14906.4 万吨。

我国领域辽阔、油气资源丰富，根据全国第二次资源评价结果，全国石油资源量 940 亿吨，到 1995 年底仅探明地质储量 174 亿吨，资源探明率 18.5%，其中海上石油资源量 246 亿吨，目前探明地质储量仅为 12.5 亿吨，资源探明率仅 5%，需要继续努力，进一步发现更多油气田。

《中国陆相大油田》一书是我国 40 多年来广大石油勘探工作者集体辛勤劳动成果的概括。由我国一批著名地质学家和各油田的科技人员，对已发现的大油气田的形成与分布从理论的高度进行了规律性的分析与总结，可以说代表了当代石油地质的水平。当然，陆相盆地油气勘探技术与实践有待进一步发展，理论尚待进一步完善、提高，尚需更多、更深入地进行科学研究工作，以提高和发展陆相石油地质的理论与实践，发现更多的陆相大油田，这也是中国及世界不断开拓新的陆相含油气盆地的需要。

中国石油天然气总公司总经理

A handwritten signature in black ink, appearing to be '王涛' (Wang Shao), written in a cursive style.

1996 年 10 月

Preface

China is one of the earliest countries which discover and use oil and natural gas. At about 100 or 200 B. C., oil was discovered in northern Shanxi province. Taken the “zhuotong jing” technique that was created in China at A. D. 1100 as a sign, petroleum geology and exploration in ancient China were once in a leading position in the world. However, in more than 70 years from 1878 when new types of machines were firstly used to drill oil wells to 1949, Chinese petroleum industry had been developed slowly, for example, only 169 wells in all was drilled, and more than 2.7 million tons of crude oil were produced. The oil products needed in China were basically imported from foreign countries. Thus, foreign experts given a very pessimistic evaluation to the petroleum resources of China, for example, they thought “lean oil in non-marine”, “lean oil in China” and so on.

After the founding of the People's Republic of China, as the broad petroleum staffs and workers relied on the science, braved in practice, started in difficulties, and did pioneering works in probing, this made oil industry continuously developed and strengthened. In 1950s, Karamay oilfield in Xinjiang Uyger Autonomous Region, Lenhu oilfield in Qinhai province and so on were successfully discovered in northwestern region, and oil explorations were developed progressively in northeastern region, northern region, southwestem region and so on in China. In the early of 1960s, the conducted Daqing batttle for oil was the major turn in the developing history of petroleum industry of our country. The victory of this battle brought about the basic self-sufficient of the petroleum in our country, and it broke the inference of “China poor in oil” by the found major non-marine oilfield. Thereafter oil exploration further extensively was carried out, found one after another oilfield rich in reserves, such as Shengli, Dagang, Liaohe, Huabei, Zhongyuan and so on. The crude oil was increased rapidly, and broken through 100 million tons in 1978. From then on, our country had entered the ranks of major oil producing countries in the world. Since reform and opening up to the outside, the oil industry has gotten into new development period that, the oil and natural gas exploration was comprehensively developed from land to offshore. Through the great amounts of exploration and development practices, the theories of petroleum geology were continuously improved, simultaneously through worked with foreign and imported new exploration technology and equipments, our exploration technology and management approach international level. At that period, a series of exploration experiences had been summarized which was suited to complex oil and natural gas accumulations of non-marine deposits. The development of petroleum science and technology at that period was the fastest in more than 40 years.

Through arduous struggle and a large amounts of oil and natural gas exploration practices in more than 40 years, 419 oilfields have been discovered in non-marine basins of our country, 32 oilfields of which are major oilfields of more than 3200 million tons in reserves. The major oilfields are widely dispersed over our country, from Tarim, Junggar, and Turpan-Hami basins located over southern and northern of Tianshan mountain in western region, to Shangganning basin in middle region, to Songliao, Bohai bay basins in eastern region and the continental shelf in the South China Sea. In the basin type, major oilfields are distributed over the foreland basin and the cratonic basin in middle and western region or the rift basin in eastern region. In the geologic age, major non-marine oilfields were discovered in Cenozoic, Mesozoic, Palaeozoic, and even Proterozoic and Archaean. There are inherent laws in the formation and distribution of the major non-marine oilfields in China. There are about five types of laws from the theoretical analysis of petroleum system: (1) the central uplift type (bulge in sag), such as Daqing oilfield, Wenliu oilfield. (2) arch drape anticline type, such as Gudao oilfield, Gudong oilfield. (3) the basement buried hill type, such as Renqiu oilfield. (4) the sag side ramp type, such as Shuguang-Huanxiling oilfield. (5) the major sag lithology oilfield type, such as Yushuling oilfield, Chaoyanggou oilfield in Sanzhao sag. Through exploration practice and probing about 40 years, a series of petroleum geologic theories with the non-marine characteristic of China have been established. They include mainly: the theory of non-marine oil and natural gas formation, the theory of Chinese oil and natural gas bearing basin type, the theory of complex oil and natural gas accumulation provinces and the theory of coalbed resources, as well as the depositional system of non-marine lake basin, the theory and approach of reservoir evaluation and so on. The major oilfields have been continuously discovered by using above theories to guide exploration practice, which have made the oil production of our country increased steadily so that the oil production in 1995 reached more than 149 million tons.

The vast territory of our country is rich in oil and natural gas resources. According to the second assessment result on resources of whole country, the total oil resources of whole nation is 94 billion tons. By the end of 1995, only the proved reserves in place have reached 17.4 billion tons and the rate of proved resources is 18.5 per cent. The marine oil resources volume in the total oil resources are 24.6 billion tons, while the present proved reserves in place are merely 1250 million tons so that the rate of proved resources only account for 5 per cent. Thus, it needs us to continue making great efforts so as to further discover more oil and natural gas fields.

The book "Major Non-marine Oilfields of China" has summarized the collective hardworking achievements of the broad masses of oil exploration researchers of our country for more than 40 years. The regularity analysis and summary to the formation and distribution of major oil and natural gas fields discovered has been theoretically carried on by a group of famous geologists and scientific and technical personal of every oilfield in China. It may say that the book represents the level of modern petroleum geology. Of course, the technique and practice of exploration for oil and natural gas in non-marine basins remains to be further developed. The theory of it still needs

to be further perfected and improved. It is still necessary to more and still deeper carry on the scientific research works to enhance and develop the theory and practice of petroleum geology of non-marine. It is also the needs in China and the whole world to continuously open up new oil and natural gas bearing basins of non-marine that finds more major oilfields in non-marine deposits.

Wang Tao
President of CNPC

前 言

中国陆相沉积著称于世界。从古生代末，二叠纪开始，中国北方地壳抬升，形成南海、北陆的格局。早、中三叠纪在印支运动后，地壳上升，扬子地台与北方大陆拼接，中国东部已连成一片大陆，南海、北陆的局面已经为东西分异格局所替代，除中国西南部的特提斯海域外，整个中国大陆形成了星罗棋布、大小不等的中新生代的陆相沉积盆地，因而中国的大油田与绝大部分的石油储量都赋存于中新生代含油气盆地之中。

新中国建立以后，石油勘探工作蓬勃发展，全国已累计打探井 3.3 万口，共钻各类油气井 16 万口，地震勘探近 300 万公里。1955 年我国第一次在新疆准噶尔盆地发现克拉玛依大油田，1959 年 9 月又在松辽盆地发现世界级巨型的大庆油田。60~80 年代在渤海湾盆地，西北地区和海上发现了众多的陆相大油气田。截至目前为止，已在中国 7 个大型的陆相盆地中发现了亿吨级地质储量的大油田 32 个，合计地质储量 116 亿吨，全国年产油 1.49 亿吨就主要产自这 32 个大油田。但是，也要看到我国陆相油田地质的复杂性，由于我国地处全球大地构造印度板块、欧亚板块和太平洋板块的结合部，构造运动强烈，断裂发育，地壳破碎，加之陆相沉积的不稳定性，岩性岩相变化大，因而形成的油气田都比较分散，以中、小型油田居多，已发现的 419 个油田中，亿吨级储量的大油田只有 32 个，仅占油田总数的 7.6%，而储量却占 67%，因而总结陆相大油田形成条件与规律以指导陆相盆地油气勘探，将是一项十分重要的任务。

根据中国陆相盆地客观实际，拟将陆相油田规模划分为 5 个级别：(1) 巨型油田：地质储量大于 15 亿吨，如大庆油田。(2) 特大型油田：地质储量在 5~15 亿吨，如克拉玛依油田和曙光、欢喜岭油田。(3) 大型油田：地质储量在 1~5 亿吨，如任丘、胜坨、孤岛、文留等油田，全国共 29 个。(4) 中型油田：地质储量在 0.1~1 亿吨，全国共 170 个，占油田总数 40.5%。(5) 小型油田：地质储量在 0.1 亿吨以下，全国共 217 个，占油田总数的 52%。

本书中所指的大油田是地质储量在 1 亿吨以上的油田，考虑到油田控制储量、预测储量和今后油田滚动发展，将个别邻近亿吨级探明地质储量的油田也列入大油田的行列。对于一些小凹陷中相对储量集中，且具有陆相石油地质特色的油田，如江汉盆地的王场油田、苏北盆地的真武油田，也将在本书大油田各论中介绍。

《中国陆相大油田》一书，是我国 40 多年来对陆相盆地油气勘探成果的系统总结，是我国石油战线职工 40 多年来集体辛勤劳动的成果。1992 年 2 月中国石油天然气总公司以 (92) 中油勘字第 94 号文件下达各油田，要求总结编写《中国陆相大油田规律与勘探经验》，列为“八五”重点科研项目，于 1995 年完成并通过验收。又经过一年的编审，在科研报告基础上精炼提高，于 1996 年 11 月验收定稿交石油工业出版社出版发行。本书共分上下两篇。上篇综述，论述陆相大油田形成的地质基础，是各含油气盆地、坳陷大油田形成与分布理论性、规律性的总结。由我国著名的石油地质专家和各油田总地质师撰写，共选编了 30 篇文章；下篇大油田各论，是对中国陆相盆地中 38 个大油气田和有特色的陆相油田的油田发现史，油田地质特征、形成条件等进行总结，由各油田组织有经验的专家编写。本书由原

中国石油天然气总公司总经理王涛作序，陆相大油田照片由张文昭选编。序、前言、目录由徐凤银翻译成英文。本书承蒙程永才、关德范、康竹林、关增森、高鹏云、杨宪一等同志在编审出版过程中做了大量编审组织工作，在此一并感谢。由于《中国陆相大油田》理论性、技术性强，涉及面广，加之时间仓促，经验不足，水平有限，在编写和出版过程中难免有不妥之处，敬请广大读者提出宝贵意见。

张文昭
1996年10月30日

Introduction

The non-marine deposits of China are very famous in the world. From the Permian period of the end of the Palaeozoic era on, the crust uplift of the northern China leads to a framework that the southern China is in the sea and the northern in the land (they are called "Southern sea and Northern land" for short). After the Indosinian movement in the early and middle Triassic period, the crustal raise causes the piece together of Yangtze plate and the northern continent of China. As a result, the eastern China has already joined a piece of great continent and the situation of Southern sea and Northern land has been replaced by the pattern of the differential of the Eastern and the Western. Except for the Tethys of the southwestern China, the whole great Chinese continent had formed the non-marine basins of Mesozoic era and Cenozoic era that spreaded all over the place and in different sizes. Thus, major oilfields of China and absolute majority of oil reserves are in the oil and natural gas bearing basins of Mesozoic era and Cenozoic era.

After the founding of People's Republic of China, the work of petroleum exploration has developed vigorously. The whole country has drilled 33000 exploration wells and 160000 oil and natural gas wells of other kinds. The length of seismic exploration of the whole country approximately equal to 3000000 kilometer. In 1955, our country discovered Karamay supergiant oilfield in Junggar basin of Xinjiang Uygur Aotonomous Region for the first time. Then in September 1959, giant Daqing oilfield of world scale was discovered in Songliao basin. In the 1960s ~ 1980s, numerous major non-marine oil and natural gas fields were discovered in northwestern region and offshore region of Bohai bay basin. Up to now, 32 major oilfields, each with over hundred million ton reserves in place, whose reserves in place amount to 11.6 billion ton have been discovered in seven large scale non-marine basins of China. One hundred and forty-nine million tons oil per year in whole country mainly comes from these 32 major oilfields. However, it is necessary to recognize that geologic complex characters of non-marine oilfields in our country. Because not only the massif of our country lies to the joint position of global geotectonic Indian plate, Eurasian plate and Pacific plate where tectonic movements are violent, fractures are in growth and the crust is broken, but also there is unstability of non-marine deposit and great change of lithology and lithofacies in it, the oil and natural gas fields formed are relatively scattered and the middle and small sized oilfields are in the majority. Among 419 discovered oilfields, there are only 32 major oilfields of hundred million ton reserves in place. They account merely for 7.6 per cent in total oilfields, but their reserves occupy 76 per cent of the total. Thus, it will be an extremely important duty that summarizes the formation conditions and laws of major oilfields in non-marine so as to guide oil and natural gas explorations of non-marine basins.

On the basis of objective practice in non-marine basins of China, We intend to divide non-marine oilfields into five grades as follow: (1) giant oilfield: geological reserves is more than 1.5 billion tons, such as Daqing oilfield. (2) super oilfield: geological reserves is 0.5~1.5 billion tons, such as Karamay oilfield as well as Shuguang-Huanxiling oilfield. (3) major oilfield: geological reserves is 0.1~0.5 billion tons, such as Renqiu, Shengtuo, Gudao, Wenliu oilfields and so on in whole country amount to 29. (4) middle-sized oilfield: geological reserves is 0.01~0.1 billion tons. There are 170 in whole country which accounts for 40.5 per cent of total oilfields. (5) small-sized oilfield: geological reserves is less than 0.01 billion tons, 217 in the country which accounts for 52 per cent of total oilfields.

The major fields indicated in this book are such oilfields those geological reserves are more than 0.1 billion tons. Considering oilfield control reserves and prognostic reserves as well as in future oilfield rolling development, individual oilfield close to 0.1 billion tons of the proved geological reserves are also included into major fields. Some oilfield examples in small sag, such as Wangchang oilfield in Jiangnan basin, Zhenwu oilfield in Subei basin which have relatively centralized reserves and have non-marine petroleum geologic characteristics will also be introduced in section two of this book.

The book, "Major Non-marine Oilfields of China", has systematically summarized the exploration achievements for oil and natural gas in non-marine basins of our country for more than 40 years. It also is the collective hardworking results of our staff and workers of petroleum profession for more than 40 years. In February 1992, China National Petroleum Corporation (CNPC) delivered No. 94 document of CNPC to each oilfield. This document required every oilfield to summarize and compile "The Law and Exploration Experience of Major Non-marine Oilfields in China", and listed it into major scientific research project of the eighth five year plan. This book was firstly accomplished and preliminary passed through checking and accepting in 1995. Then by reading and editing for one year, it had been refined and improved on the basis of scientific research reports, and finally, in November 1996, it was checked and accepted, finalized and delivered to the Petroleum Industry Press to be published and issued. This book includes two sections. The first section is general statement, that introduces the geological basis of the formation of major non-marine oilfields, gives theoretical and regular summary of formation and distribution of major oilfields in each oil and natural gas bearing basin and depression. This section includes 30 papers which were written by famous petroleum geologists of our country and chief geologists from every oilfields. The second section is separate statement of major oilfields, that summarizes the oilfield discovery history, oilfield geologic features, formation conditions and so on of 38 major fields and characteristic non-marine oilfields in non-marine basins of China. The papers of this section were written by the experienced experts of each oilfield. The preface of this book was written by Wang Tao who is the president of CNPC. The photographs of major non-marine oilfields were selected and compiled by Zhang Wenzhao. The preface, introduction and contents were translated into English by Xu Fengyin. This book was granted a large amounts of reading and editing and organizing work by Chen Yongcai, Guan Defan, Kang Zhuling, Guan Zenmiao,

Gao Penyong and Yang Xianyi during its reading and editing and publishing time. Here thanks all of these experts for their help. Because the book "Major Non-marine Oilfields of China" is strong in theory and technology and deals with a wide range of disciplines and technologies, moreover, because of hurried time, insufficient experience and limited cultural level, there might be mistake and inappropriate places in compiling and publishing, and we request the honour of raising valuable suggestion by the reading public.

Zhang Wenzhao

30 Oct. 1996

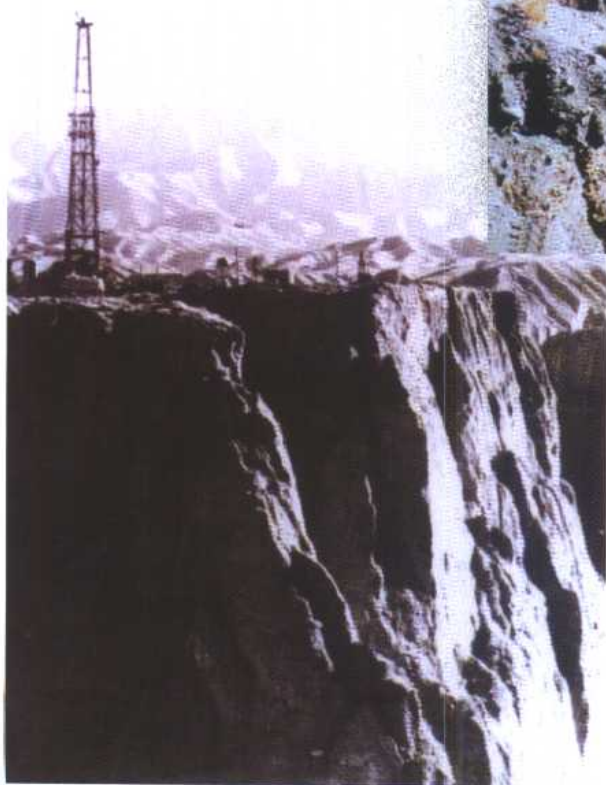
探 区 风 光



33. 四川盆地山地地震——山地钻机在施工。



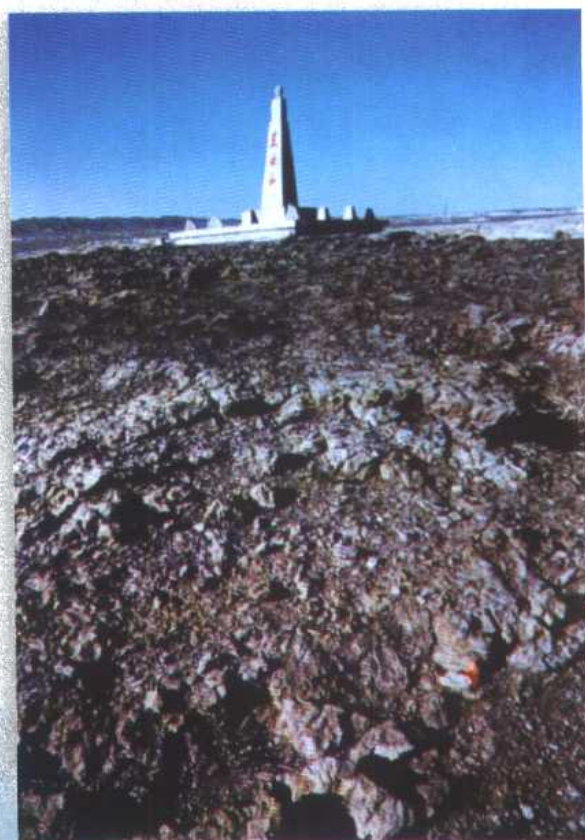
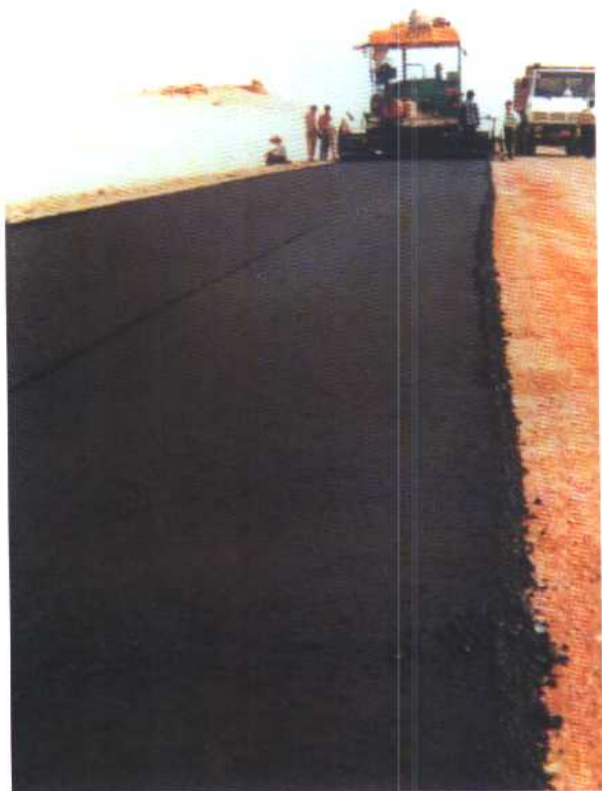
34. 玉门石油河——中国石油勘探开发发源地。



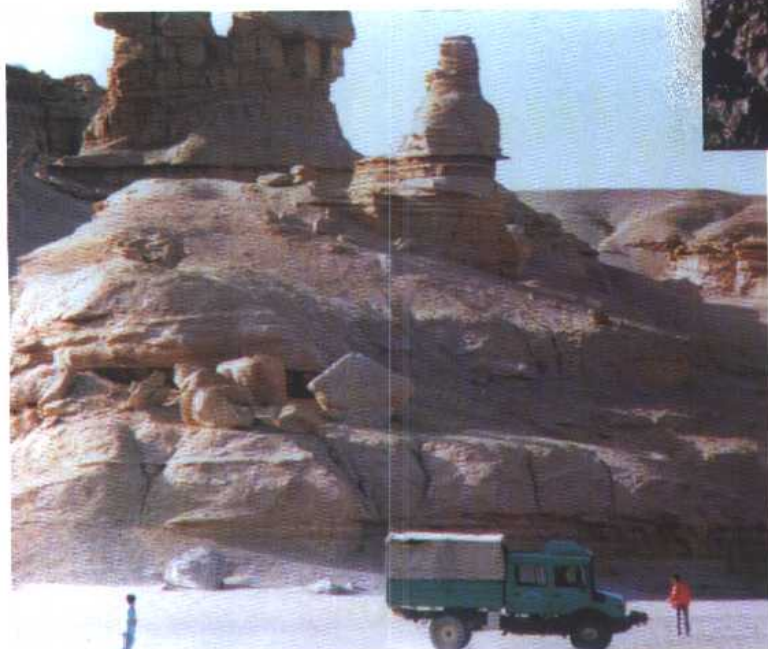
35. 祁连山下的玉门油田一角。

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36. 新疆准噶尔盆地彩南沙漠油田修起沙漠公路。



37. 黑油山——准噶尔盆地西北缘沥青丘和油苗露头。



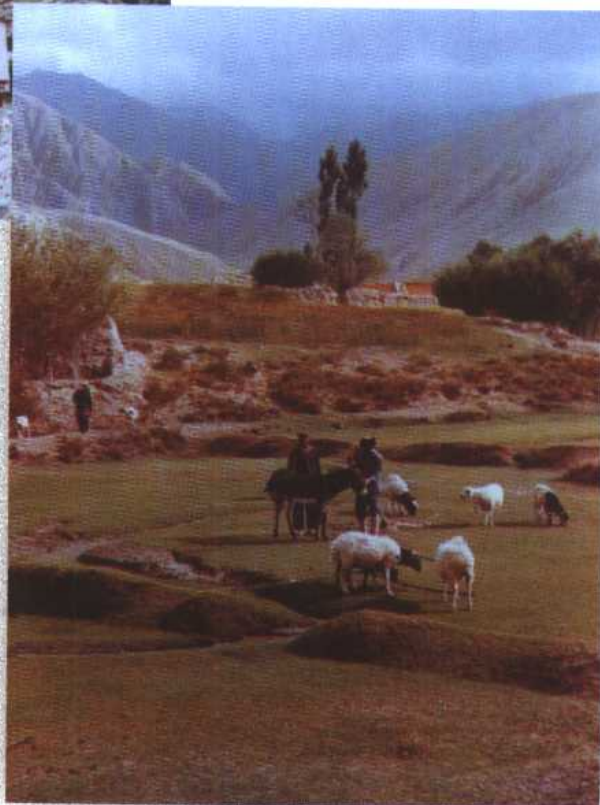
38. 准噶尔盆地西北缘探区——魔鬼城。

探 区 风 光

39. 1956 年克拉玛依油田评价——大剖面电开钻探。



40. 天山脚下吐鲁番—哈密探区一角。



41. 昆仑山下——中国西部油气探区之一。