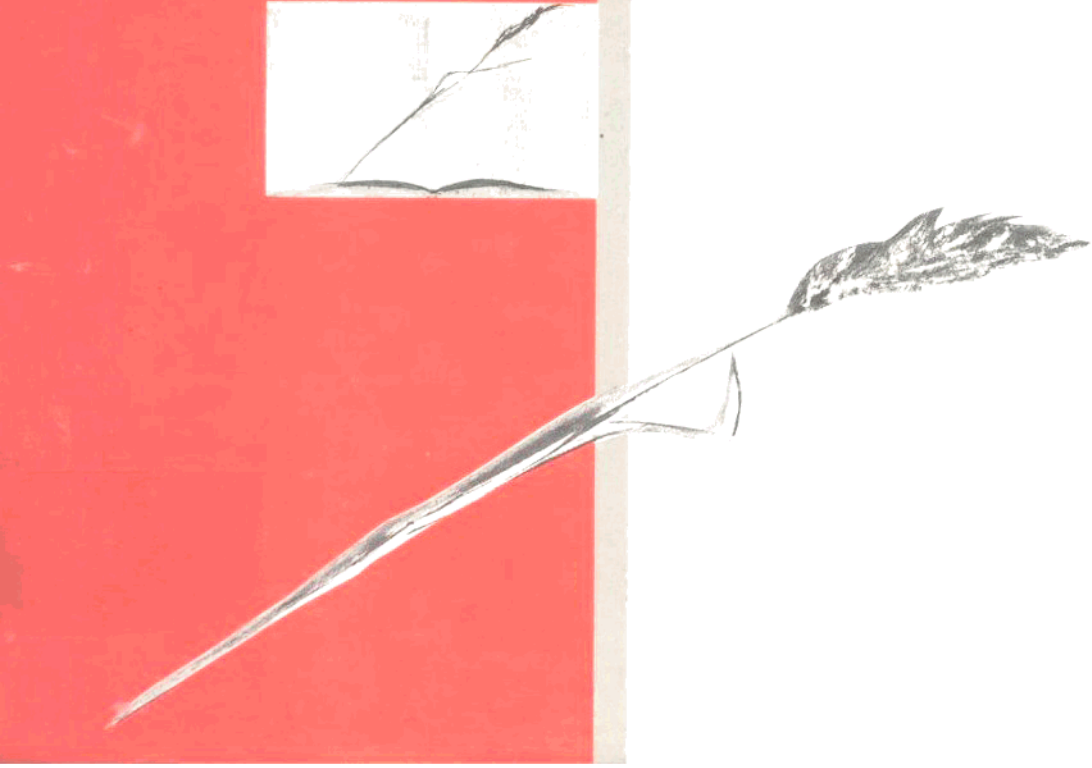
GANG OIL FIELD SCIENCE AND TECHNOLOGY MEMOIR

# 大港油田科技论文集

1964–1994



——谨以此书

献给大港油田

开发建设三十周年

# 大港油田科技论文集
# 编辑委员会

# 序

SY67/14

大港油田作为我国沿海大城市中的石油天然气能源基地，开发建设已经整整三十个年头了。

当此之际，我们把三十年来的科技论文精粹，分门别类，加以提炼，编纂成书，近早付梓，献给大港油田的创业者和建设者，献给为大港油田发展辛勤耕耘的广大科技工作者，献给关心大港油田发展的各界朋友们。

对历史的系统总结必然会启迪未来，对未来的准确把握无疑可诠释历史。《大港油田科技论文集》在各方面的关怀下，经编辑们的共同努力，今天终于同大家见面了。《大港油田科技论文集》共收录105篇论文，百余万字，它从不同侧面反映了大港油田三十年的科技发展历程，反映了油田各条战线不同时期的重要科技成果和发展水平。这本论文集是三十年来油田广大科技工作者集体智慧的结晶，记载了广大科技工作者三十年来不畏艰辛，知难而进，大胆实践，勇攀高峰的奋斗史，具有较高的理论水平和较强的参考价值。《大港油田科技论文集》的出版，是大港油田的一件大事，也是向大港油田三十周年庆典献上的一份厚礼。

科技兴，则油田兴。这是油田三十年发展的经验总结。而立之年的大港油田，已进入中后期开发阶段，勘探开发难度越来越大，同时伴随着社会主义市场经济体制的建立和完善，作为油气田企业的最根本问题就是要在提高经济效益的前提下，保持油田的持续稳定发展。解决好这个问题的根本就是要坚定不移地依靠科技进步，坚持“科技兴油”战略，通过科技的振兴，实现油田发展的腾飞。油田广大科技工作者要肩负起这一历史重任，从《大港油田科技论文集》中得到启示，继续深化科学研究，不断提高油田科技水平，为油田发展铸造科技腾飞的翅膀。

1994.1

# PREFACE

Dagang Oil Field is the only one as oil-gas energy base in the coastal of our country. It has developed and constructed for thirty years.

In this time, the essence in science and technonogy in 30 years by classification are compiled into this book to offer to the Dagang Oil Field's pioneers, builders, numerous science-technology workers who are working hard for the oil field development, and many friends who concern this oil field.

It can certainly enlighten the future to sum the history systemetically, and it may certainly annoted the history to control the future accurately. With concern of each sides and in a common effort of the editors, "Dagang Oil Field Science-Technology Memoir" meets everybody at last. It has collected for 105 papers including nearly one million words which show the scientific-technical development history in 30 years from different sides and reflect the important scientific-technical results and their levels from each production battle line in different stages. This symposium is the collective inteligence's crystal of the science-technology workers in the 30 years. It has recorded the history of numerous science-technology workers who showed defying difficulties and hardshipes, advancing despite difficulties, boldly at practice and boldly in scaling hights. It has higher theory level and bigger reference value. Its publication is an important affair and is also a heavy present for offering to Dagang Oil Field's thirty anniversaries.

If sciece-technology is rejuvenating, the oil field would be rejuvenating. That is the summary for the oil field development in the 30 years.

Now, the oil field has entered the middle-late development stage, so the degree of difficulties in exploration and development is higher and higher.

With the socialist market-economy system constructing and completing, the first question for oil enterprises is to keep development continuously and stably based on promoting economic benefit.

The key for solving this problem is to rely on science progress unshakabaly, and adhere to the strategy for rejuvenating this oil field by science and technology, that is , by science-technology rejuvenation performs the oil field development at full speed. For wide science-technonogy workers in Dagang Oil Field need to undertake this history important task and gain enlightenment from "Dagang Oil Field Science-Technology Memoir". And also they will continuouly need to deepen scientific research, to rise science-technology level, and to cast both wings for the oil field development.

**Sun Xijing**
**January, 1994**

# 前　言

大港油田——我国石油工业的重要基地之一。它屹立于渤海之滨，已经整整三十个春秋了。

值此之际，我们把30年来科技论文精粹，编纂成书，献给大港油田的创业者和建设者，献给大港油田的新一代，献给关心大港油田发展的朋友们。

“科学技术是第一生产力”。油田是知识密集、技术密集型企业。大港油田辖区地面和地下地质条件又十分复杂。30年来大港油田广大科技工作者知难而进，勇攀高峰，艰苦奋斗，勇于实践，攻克了生产中一个又一个技术难关，建成年产400万吨的大油气田。大港油田开发的前10年，地质勘探以“背斜聚油”理论指导，发现了港西、港东、唐家河、羊三木、孔店、王徐庄、周青庄、板桥、六间房等一大批各种背斜油气藏和断鼻构造油气藏。工艺技术以单机和单项科技攻关为重点，取得了千米刮刀钻头、钻井大马力机泵组、641—Ⅱ型取芯工具、固井三项自动记录仪、声感组合测井系列、河251型封隔器、植物冻胶压裂液等一批科技成果，解决了勘探开发建设中的关键技术。1967年用自己设计的CT—100型长筒取芯工具，油基泥浆，在港205井创一次取芯145.42m，收获率100%的全国纪录。70年代中期到80年代中期的10年，勘探研究提出“断裂控油”的新认识和“大断裂两侧，沿主断找高产”的部署原则，以二级构造带为勘探对象，发现了枣南、自来屯、歧50、官80、滨南、歧15等地垒，抬斜及交叉断层等多种类型高产断块油藏。深浅侧向与微侧向组成的盐水钻井液测井系列，高压喷射钻井综合技术，偏心配水、涂料油管与流量计测试三配套的分层注水技术，高温压裂液、陶粒支撑剂与压裂管柱相配套的深井压裂工艺等一批配套技术成果，大大提高了油田专业工艺技术配套水平和生产能力。近10年间，研究总结出“复式油气藏理论”，勘探由二级构造带向斜坡和凹陷带及隐蔽油气藏扩展，大张坨、联盟、滨北、歧北砂岩体、风化店中生界安山岩、孔东官142、歧647等油气藏相继发现，油气勘探进入整体解剖、立体评价的新阶段。以地震及测井资料预测地层压力为基础的近平衡钻井技术，以分层测试、调剖、堵水等多项技术为内容的区块综合调整技术，定向井丛式井钻井技术，聚合物驱三次采油先导试验以及枣园油田提高开发效果研究等一批综合研究成果，标志着油田科学技术进入多学科、跨专业、多工种的系统工程研究阶段。以枣园油田提高开发效果研究为例，与高等院校、科研机构合作的“产学研”集团经四年攻关取得了特殊复杂断块油藏精细描述、储层综合评价、非牛顿原油渗流特性、采油方式优选及建立井筒热力场的水杆、电杆采油技术和改善水质的注水技术等系统配套的理论和技术成果，对这种特殊复杂油田所采取的攻关技术，取得成功的开发效果，在国际上也属少见。

30年来，油气地质勘探引进并掌握了定量评价烃源岩生烃能力的干酪根热降解成烃理论和有机地球化学分析手段，研究推广了评价储集体的地震地层学、横向预测技术和油藏描述技术，应用裂谷理论研究拉张裂陷型盆地，预测构造带含油类型及圈闭体的分布规律，创立了一套渤海湾含油区断陷型含油气盆地复式油气藏理论和勘探方法，达到国际领先水平。地球物理勘探和测井引进数字地震仪、数控测井仪、中型处理机、解释工作站及相应软件，装备和技术更新跟上了国际水平，还掌握了市区地震施工技术，首次在我国城市区（塘沽市

区）成功地进行了三维地震勘探施工，在国内较早发展了过油管负压射孔和油管传输射孔技术。钻井工艺装备全面配套发展，建成面向全国的定向井技术服务中心，定向井丛式井钻井技术处于国内领先水平。积累了复杂断块油田、疏松砂岩油田、深层低渗透砂岩油藏、高凝稠油油田和凝析油气田的开发经验，建立了相应的开发理论、方案优化方法和配套的工艺技术手段。具备了三次采油室内和现场试验能力，可以独立进行聚合物驱油设计、施工和效果评价。建成了我国第一个滩海人工岛，具备了由陆地入海的滩海区域油气勘探开发能力。油气集输与储运的设计施工技术达到国内同行业先进水平。石油加工，利用羊三木环烷基低凝原油特性研制的橡胶填充油、锂基脂、45 号变压器油等新油品已占领国内市场，并成为打出国门的创汇产品。在油田广泛普及应用现代化管理方法，使科研攻关和生产技术工作的效率及效益大大提高。科技信息研究，在一些领域走到了生产、科研的前面，成为科技发展的先头兵。

《大港油田科技论文集》收录的 105 篇（100 多万字）论文，是从 30 年来在国内外公开出版发行的 39 种期刊杂志及重要学术会议文件以及特约征集的共 450 篇（约 400 万字）论文中，本着科学性、独创性、资料性和广泛性原则筛选出来的，它从不同侧面反映了大港油田 30 年的科技发展历程，反映了油田各条战线不同时期的重要科技成果和发展水平。因此，《大港油田科技论文集》从某种意义上说是一部大港油田 30 年科技史，可以起到“资治、教化、存史”的作用，为科技兴油，振兴大港服务。因篇幅所限，不少好文章未能入选，深表憾意。由于编辑时间较紧，加之人手不足，文中定会存在不少纰缪，望专家和读者批评指正。

1993 年 11 月

# INTRODUCTION

Dagang Oil Field is one of the important oil bases in the industry of our country. It has standed on the coast of Bohai Sea for 30 years.

In this time, the essence in science and technology in the 30 years were compiled in this book to effer to the Dagang Oil Field's pioneers, builders and new generation, and the friends who are interesting this oil field development.

" Science and technology are the first productive force" .Oil field belongs to knowlege–technology density interprise, especially, the surface and underground geological conditions in Dagang Oil Field area are very complex. In the 30 years, this oil field's scientific and technical workers showing the spirits of advancing despite difficulties, boldly in scaling hights, hard at work and boldly at practice have surmounted one and one of the productive technical difficulties to have built–up oil production as 4 millions tons / year. In the first 10 years of this oil field development, a large batch of anticline and faulted nose structures oil fields, such as the west and east Dagang, Tangjiahe, Yangsanmu, Kongdian, Wangxuzhuang, Zhouqingzhuang, Banqao, Liujianfang etc. had been found by "anticline accumulating oil theory" directing, the geological exploration. The important point in technicl attacking had been as single machine and single item to have obtained a large number scintific results, such as drilling 1,000m's drag bit, large horsepower machine–pump assemblage for drilling, 641–II Type coring tool, three items automatic recording unit for cementing, acoustic–induction logging system, He–251 Type packer, vegetable glue frac fluid etc., that solved the key technical problems in exploration and development. In 1967, the domestic coring record, for core as 145.42m long in once with recovery 100% had been set up by using self designed CT–100 Type long pipe coring tool with oil–base mud in Well Gang–205. In the 10 years from the middle period of 1970's to the middle period of 1980's, the new knowlege for "oil controlled by faults" and well distributing law for "along the both sides of large faults looking for high production" and the exploratory targets as secondary degree structure belts in exploration had been put forward to have fined horst, anticline and cross faults etc.types high production faulted block oil pools, such as Zaonan, Zilaitun, Qi 50, Guan 80, Binnan, Qi 15 etc. A batch of technical results, such as deep, shallow and microlaterolog systems for brine water mud, high pressure jeted integral drilling technologies, separating zone water injection technique including the matched three parts of eccentric water injection and coating tubing with flowmeter measuring, high temperature frac fluid and haydite proppant with frac–string matching techniques for deep well fracturing etc. have greatly raised the professional technical matching level and production capacity of the oil field. In the recently 10 years, for "complex–forms oil–gas pools theory" and the exploration from secondary degree structure zones extented to slope and sag zones and concealed oil–gas

pools have been summarized out successively to have fined Dazhangtou, Lianmang, Binbai, Qibai sand body, Fenghuadian Mesozoic andesite, Kongdong Guan-142, Qi 647 oil and gas pools etc. The oil and gas exploration has got into the new stage of integral dissection and three dimensional evaluation. A batch of integral reserach results including the balanced drilling technique based on seismic and logging data predicting formation pressure, for block comprehensive adjustment by zonal testing and integral dissection with water shutoff multi-item technologies combination etc., deviated and cluster wells drilling technologies, polymer flooding tertiary oil recovery pilot testing and raising develepment effect in Zaoyuan Oilfield etc. have indicated that this oilfield's science and technology has entered the systematic engineering researching stage for multiple disciplines and stridding specialities with multiple-types of work in production. By Zaoyuan Oil Field in raising developmental effect research as an example, the co-operating organization with universities and research institutes had tackled the key problems for four years to have obtained the systematic matching theories and technical results for meticulously describing complex-faulted block oil pools, integral reservoir evaluation, non-Newtonian crude oil seepage flow characteristics, producing manner option, building water and electric bar producing technique in well bore thermodynamic field, and water injection technique for improving water quality, etc. It is seldom seen in the world to obtain succesive developmental effects to such special complex oil field adopted techniques.

During this 30 years, in oil-gas exploration the Kerogen pyrolysis generating hydrocarbon theory and organic chemical analysis method for quantitatively evaluating hydrocarbon generating capacity in source rock have been imported and used in practice, seicmic stratigraphy for reservoir evaluation and lateral prediction, and reservoir description have been researched and spreaded, the rift theory has been used for researching extensional rifted-basin and predicting oil bearing types in structure zones and distributing regulations for closure bodies, and a set of complex-forms oil pool theories in the rifted-basin of Bohai Bay and exploration methods have been set up and it is in the lead of the world. In geophysical prospecting and well logging, the digital seismic equipment, digital controlling logging tool, middle - type processor, interpretation workstation and their corresponding softwares, etc. have been imported and these equipments and technologies and their renewal have followed up the world level, for seismic survey in urban district has also been mastered and three dimensional seismic survey progressed in Tanggou district is the first time in our country and have got a lot of successes, and for through tubing perforating (TTP) and tubing conveyed perforating (TCP) techniques have been developed and it is the earliest one in our country. The corollary drilling-technical equipments are developed and the deviated well service center to the whole nation was found, for deviated well and cluster wells technologies are in the lead level of our country. The developmental experiences of complex faulted block oil field, loose sand oilfield, deeply buried and lower permeability sand oilfield, high solidification viscous oil oil field and condensate oil- gas field etc. have been accumulated and established the corresponding recovery theories, program option methods

and matched technical measures. There are the capacities for tertiary recovery oil tests in laboratory and on－site, and polymer flooding program design, practice and evaluation etc. It built the first artificial island in our country and has formed the capacities in exploration and development in the seabeach area. For oil－gas gathering and transfering program design and practice technologies are up to the advanced level in the native same trade. In oil refining, using naphthenic based low－solitification oil in Yangsanmou area manufactured the new products that include rubben filling oil, lithium based grease and No.45 transformer oil etc. have occupied the domestic markets and exported to the international markets. Because the modern administration methods have extensively been applied in the whole oilfield, it makes the scientific research and technical work's efficiency and economic benefit greatly raised. For scientific information research in some regions has walked in the front of the production and scientific research to play a scientific and technical development's vanguard role.

"Dagang Oilfield Science and Technology Memovirs" collected 105 papers with about 1 millions words that were optimized in 450 papers with 4 millions words which have been published in 39 kinds journals, important academic conference symposiums and special contributions according to their scientific value, original creation and extensive application standards etc. That reflected the scientific and technical development course in different sides and showed the scientific and technical results and their development levels in different stages on each production battle line in the 30 years of the whole oilfield. So this memovir in a sense is the science and technology history of the oilfield in 30 years and can play a "managing, instructing and filing" role and serves the purposes of prospecting oil by science and technology and rejuvenating Dagang. It's a pity to that many good articales couldn't been selected in it due to limited space. The time for compiling is too tight and shorthanded, so it may contains some miskates, we hope the experts and readers to give criticism and indication.

Chen Guangyu
November, 1993

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