



欧庆贤

石油物探文选

石油工业出版社

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## 内 容 提 要

本书收集了欧庆贤同志1974~1995年撰写的部分文章34篇。内容包括技术思想、技术评论、技术发展和技术管理等方面。

本书可供油气地球物理勘探、其他地学科技人员和有关院校师生参考。

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## 序

欧庆贤教授是我国著名地球物理学家,是我国石油物探工作的开拓者之一。1953年至1969年在北京地质学院物探系任教,组建了地震勘探教学科研实体,主编了我国第一部地震勘探高校教材,培养了一大批地球物理勘探的高级技术人才。1969年至1978年欧庆贤先生在地质部第三石油普查大队工作,参加了长庆石油会战。为突破陕甘宁黄土塬地区的地震方法关,他率先提出有关激发控制和弯线多次叠加新概念,为加快长庆油田的发现做出了重要贡献。1978年,欧庆贤先生调南京地质矿产部石油物探研究所,参加研究所的组建,随后主持研究所的技术业务工作。在此期间,他主持了三维地震勘探方法的研究和实践,同时大力倡导组织、指导多波勘探、超多道地震、岩性勘探、高分辨率地震和人机联作解释等新技术的研究和应用。

在“六五”和“七五”期间,欧庆贤先生主持完成了“南方海相碳酸盐岩地区油气勘探”方面的国家重点科技攻关项目,经国家级评审委员会验收认为,这项科研成果达到了国际水平,获国家科技进步奖。欧庆贤先生积极组织和参加了国内外地球物理学界的学术交流,现任《石油物探》杂志主编、中国地球物理学会和中国石油物探学会理事、江苏省地球物理学会理事长等职。为提高我国地球物理学科的学术水平,扩大在国际上的影响做了大量的工作。

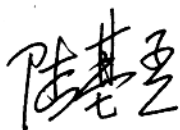
欧庆贤先生献身地球物理勘探事业40多年。从纵的方面,他亲自经历、积极参与和组织领导了我国石油物探事业迅速发展以及方法技术不断革新的各个阶段;从横的方面,他又曾先后在这一学科的教学、生产、科研部门工作,并都做出了显著成绩。本文集的34篇论文就是从 he 发表的论文中精选出来的代表作。这些论文在我国地球物理勘探发展的各个时期,都起过重要作用,并为地球物理学科的发展做出了有益的贡献。

欧庆贤先生勤奋好学、专业理论基础扎实、功底深厚、学术思想活跃和有多方面的丰富的实践经验,并勇于创新。他的论文有几个突出的特点:第一,把这些论文按时间顺序排列,基本上就反映了我国从70年代地震勘探方法技术跨入模拟磁带技术阶段后,推广多次叠加,不久又实现数字化,直到近几年的三维地震多波勘探、岩性勘探、人机联作解释等新技术研究应用发展的脉络。在每个阶段他都从勘探战略的高度,阐述了一些全局性的方向性的问题。第二,论文思路开阔,充满了辩证法,用精辟的富有说服力的分析,启发人们革新常规的、多年来习惯的旧方式方法,更快地认识和接受新事物,采用新方法。对人们更新观念,推广新技术起了十分积极的推动作用。第三,论文中体现了严谨的科学态度和不唯书、不唯上的科学道德,洋溢着自尊自强的爱国主义精神。他一再强调,要坚持改革开放,引进外国先进技术,但也要注意继续发扬自立更生、独立自主精神,不要因为引进而抑制了自己的创造力和制造力。他提醒人们,在今天要努力培养出更具有事业心责任感和热爱我国物探事业的人,不要只培养出一些别人的技术“工具”。他激动地呼吁,既要爱护那些为国外科技发展“锦上添花”的人,更应爱护那些愿作出自我牺牲为我国“雪中送炭”的同志。这些看法在当前是很有现实意义的。第四,论文的叙述,观点明确,思路清晰,分析深透,文笔流畅。即使讨论一些理论性很强的问题,也不是连篇的艰深的公式,更多是利用实例和数据使读者感到易读易懂。这些论文由于有这些鲜明的特点,现在选辑出版是很有意义的,在学术上很有价值,对我们以正确的指导思想来开展物探新技术的研究、引进、推广也很有帮助,对引导年轻一代物探工作者沿着正确的道路健康成长也是大有裨益的。

文集编好后,欧先生嘱我作序。我深深感到:请地球物理学界的专家学者来评价欧先生在这一学科的贡献,为此文集作序,会比我更合适。我是欧先生的学生,30多年来主要从事物探专业的教学工作,一直牢记毕业时欧老师的勉励:“要以砂里淘金的态度去学习,以诲人不倦精益求精的精神去教人”,不敢懈惰,边教边学。

对欧老师的这些论文的思想 and 内容,也曾认真学习并介绍给自己的学生。但为文集作序,深感难以胜任。然而,恩师之嘱,无法推辞,只好勉为其难,写了这些粗浅的体会。

欧庆贤先生热爱祖国、热爱石油物探事业,学术思想活跃,治学严谨,注重实践,淡泊名利,待人诚恳。此次请学生为他的文集作序,也足见他平易谦虚,培养后进的高贵精神。今天工作在石油物探战线上的他的学生和同行们都会为文集的出版感到欣喜。衷心祝愿欧庆贤先生为我国石油物探事业的发展做出新的贡献

A handwritten signature in black ink, reading '陆其志' (Lu Qizhi). The characters are written in a cursive, calligraphic style.

1995年2月

## PREFACE

Prof. Ou Qingxian is a renowned senior geophysicist. He has taught in the Department of Geophysics, Beijing College of Geology (later renamed China University of Geosciences) from 1953 to 1969. Mr. Ou was the leading organizer for setting up the entity which has practised the integration of teaching seismic exploration with scientific research. And he edited the first-ever seismic exploration teaching materials for higher education at large. During his tenure of office, he has trained and brought up large numbers of high-calibre and qualified scientists and technicians for this country.

Mr. Ou assumed a leading position in the 3rd Petroleum Reconnaissance Survey Party under the Ministry of Geology from 1969 to 1978 and he joined the great battle for oil in the Changqing Oilfield, central west China. From then on, for ensuring the success of making a breakthrough to conduct the seismic survey in the loess plateaux of Shaanxi, Gansu and Ningxia regions, he was the pioneer who advanced the new concepts on seismic source control and slalom line multiple coverage which have made a significant contribution in speeding up the discovery of Changqing Oilfield. Since 1978, Mr. Ou has been transferred to the Nanjing Research Institute of Geophysical Prospecting for Petroleum under the Ministry of Geology & Mineral Resources and participated in making preparations for the establishment of the RIGPP. And he has been in charge of the overall technical

work there. During which he acted as a supervisor of 3D seismic research and operation. Meanwhile, he devoted his major efforts to initiating, organizing, providing guidance to the research and application of new techniques, such as multi-component recording, large number channel seismic, lithology prospecting, high-resolution seismic, interactive interpretation etc.

During the Sixth Five-Year Plan (1981~1985) and Seventh Five-Year Plan (1986~1990) periods, Mr. Ou has been the chief manager of the State Key Project, Oil-Gas Exploration in the Marine Carbonate Area of South China, which has been successfully accomplished. The completed project has been checked and accepted by the State Appraisal Committee, It is assessed as a scientific research achievement that attained the world level and thus bestowed a reward by the government for its significant role played in promoting the technological advancement.

In addition, Mr Ou has been enthusiastic for organizing and taking part in domestic and international academic exchanges and supporting/encouraging the scientific pursuits, His current posts are chief editor of GEOPHYSICAL PROSPECTING FOR PETROLEUM, a RIGPP official journal, and board directors of Chinese Geophysical Society and China Petroleum Geophysics Society, and board chairman of Jiangsu Geophysicists Society, It is obvious to all that he has done a tremendous amount of work in terms of upgrading the geophysical operation in China so as to extend its influence in the international arena ultimately.

Mr. Ou has dedicated himself to the geophysical prospecting work for more than 40 years. Taking a historical look, one will find that he has always been very keen to organize and participate in oil exploration ventures and played a leading role, and hence he



has gained a broad firsthand experiences from various practices. What's most praiseworthy of him is that he is always ready to share them with his colleagues. It goes without saying that all these are deemed very contributive to help forge exploration geophysics speedily ahead and keep updating it methodically and technologically at all stages. As compared with his contemporary peers, we can see that whilst he taught in colleges and served at production unit and working in the research institute, he has achieved a remarkable success. The 34 papers collected in the selections are his representative works which have played a significant role for spurring on the expansion of China's geophysic prospecting at all its stages. So the does have made a valuable contribution to the exploration geophysics indeed.

The author has shown his assiduity and eagerness in learning. He has laid a solid theoretical foundation in the professional knowledge and has been active to participate in academic discussions at home and abroad. Moreover, he has acquired rich practical experiences in many aspects plus always taken bold step in making innovations. His monographs are characterized by: Firstly, when if they are chronologically arranged, one will get a picture throughout the evolutionary history of seismic exploration technique. After it has stridden into the stage of the analogue tape recording ever since 1970s, what followed were expanding the application of multiple coverage and then implementing the digitization. And it was not until recent few years, the 3D seismic survey, multi-component recording, lithology exploration, interactive interpretation etc. have become popular. Through which one can see the sequences of technological ideas that have been making progress. Mr. Ou has as always thrown in his whole ef-

forts to make a systematic exposition of the theories concerned or remarks on what was going on from the strategic point of view at crucial moment of different stages. Secondly, all of his papers reveal a sobering and long-term strategy pursued, looking at things dialectically, in-depth and convincing analyses and try to edify his colleagues to break with their outdated conventions and make daring innovations for better understand and accept the newly-merged things, and encourage them to put the new technical know-hows into use at an earlier date. This has given a great push to the technological updating as well as extended the application of up-to-date techniques. Thirdly, his papers embody a rigorous scientific approach taken and the author's professional ethics observed e. g. no bookworshipping, daring to break free from regulations/conventions set by superiors, which have been later proved to hinder the technological development etc. Also, his papers are brimmed with patriotism which finds its full expression in holding himself in proper pride while constantly striving to improve himself.

Mr. Ou emphasizes time and again that we ought to adhere closely to the policy of Reform and Opening to the Outside World at all times, and that it is of great significance to import the advanced and sophisticated technical know-hows from abroad. However, we have to pay enough attention to carry on with continued efforts the guideline, to maintain self-reliance and act independently along with the initiative in our own hands. Meanwhile, we should never restrain ourselves from creating something new and giving full play to our manufacturing ability, or to get rid of the dependent mentality relying on importation only. He warns people that today we have to spare no effort to

foster and bring up the potential dedicated successors who have to have a strong sense of responsibility for what are to be assigned and are willing to devote themselves whole-heartedly to the Chinese geophysical exploration job, and not to train only the sort of technical instrument who are inclined to serve the countries other than their motherland. He appeals emotionally to public that we should take a good care of those who are trying to add flowers to the brocade, or to make something still better, for the sake of overseas technological development. But what's more important is to cherish those who are, in any case, willing to do yeoman's service, or volunteer to offer timely assistance for this country at the expense of their personal interests whenever and wherever they are needed. This way of looking at things is of immediate significance at present day. Fourthly, from the description of the selected papers, the readers can feel the author's clear-cut stand, explicitly-presented concepts, deep insight, and easy and grace style. Even if discussing a problem with pretty much bearing of theory, there are few abstruse formulae seen therein his paper. Instead, the author provides more examples and data to help readers to better understand so as to bring home to them the importance of his exposition. All in all, because of the above distinctive characteristics in the contents of his selections, it is deemed significant to compile this collection and have it published. It is of great value in terms of academic discussion and conducive much to us to take them as a guideline to follow when carrying out research, importation or widening the application of new technology related to geophysical exploration. Furthermore, it is perhaps of benefit for the younger generation of geophysicists to serve as a guidebook to help them to grow healthily to maturity.

ty along the right course.

On the point of the selection editing is going to be done. Mr. Ou asked me to write a preface for the book. To be honest, I felt keenly that probably the notables of geophysical community would be the right persons to be invited to make an assessment of Mr. Ou's contribution made in petroleum geophysics and preface the selections with an introduction. I am Mr. Ou's student and have been involved in teaching geophysical prospecting course for more than 30 years. I always bear in mind all the forthright admonitions he urged me upon my graduation, which reads as "you have to take the attitude, to behave like panning in the sand when learning and have tireless zeal and go over your work with a finetooth comb in teaching; never slack off in studies; and learning while teaching." I have studied seriously the concepts and contents of Mr. Ou's selected papers and recommended them to my students. But I am far from being competent to do the prefacing really. However, since it's requested by a teacher I am greatly indebted to, it would be ungracious for me to decline it, so I can but undertake to do the job as best as I can. What I wrote is just my superficial understanding about Mr. Ou.

Mr. Ou loves his motherland profoundly and has dedicated his life to petroleum geophysics. He has been very aggressive and motivated in thinking about creating something new in terms of academic suppositions and noted for his meticulous scholarship, laying stress on practice, not to seek personal fame and gains, to treat people with sincerity and honesty. It is a good example that he asked his student rather than any authoritative persons to write a preface for his selections. Through which one can perceive his amiability and modesty towards people around and no-

blemindness in fostering his successors. I am sure his students and colleagues who are serving at the front of petroleum geophysics would be very glad to hear the coming-out of his selections soon. It's my sincere hope that Mr. Ou Qingxian will be able to make still more contributions to the evergrowing china's petrolum geophysics.

Prof. Lu Jimeng  
Vice President  
China University of Petroleum  
February 1995

## 前 言

谨将此文集献给我国石油物探战线的同志们！

我出这本文集的目的不在于追念过去而在于推动未来。

石油物探技术的发展基本上与世界高科技的发展同步。近十多年石油物探工作的貌似缩减和质的提高反映了油气发展和客观条件的复杂性的需要；反映了油气工业对石油物探技术的依赖。石油物探不仅已成为当前“透视”地壳内部结构、状态、组成和运动的唯一有效的技术手段；而且正在孕育形成一门与石油地质学相似的石油地球物理学，两者的结合对石油工业的发展会起着决定性的作用。

石油成为国民经济的“血液”也只有百年左右的历史。人们预测世界上的油气开采工作还可以有上百年的时间，如果考虑到“无机生气”的理论，其时间将可能会长得多，因为从这个理论出发，人们预测的天然气资源量会比现在所估算的增大百倍。因此石油物探的前景是光明的，而且所带来的影响已不限于找油气领域。

我希望此文集能对石油物探起一点促进作用，同时希望读者能理解到：

(1)技术的思想方法(思维方式)对技术的发展会起着极大的影响。

(2)一项总体性方法技术的提出、形成直到使用是要经历一段较长时间的。

(3)掌握石油物探技术发展的正确方向和方针，对石油物探能否很好地得到应用与发展是十分重要的。

(4)石油物探是一门受地域性影响较大的科学技术，要特别注意因地制宜地去研究、开发、应用和推广这门技术。

(5)将石油物探用于油气开发阶段是当今发展的必然趋势，要

主动促使她更快地、更成熟地进入这个阶段。

(6)在三维地震基础上发展的高分辨率地震、多波地震、立体地震、综合物(化)探、物性研究、人机交互综合工作站和“虚拟”采集系统等方法技术是实现进入“开发阶段”的必要方法技术。

(7)要继续充分重视解释的技术、方法、原理和模型、概念的研究、发展,因为它是实现地球物理学和地质学相结合的关键。结合就是意味着要加强相互学习和应用。

(8)我国把引进、消化、吸收、应用和自力更生、独立自主结合起来,实行“两条腿走路”的方针,就能使石油物探更好、更快地得到应用和发展。

(9)我国复杂海相碳酸盐岩的石油物探方法技术问题,在目前和今后的一段时期内都是物探技术方法中一个要探索的主题。

(10)我国石油物探技术的发展与世界的发展是“准同步”的。数十年来它在党和国家的领导下始终在前进。目前已形成坚实的技术基础体系和培养出大批优秀人才,我们应以此为荣。

今天,我国石油物探工作经过长期的艰苦奋斗和不断探索实践,已由引进、消化、吸收、应用阶段进入到引进、吸收、消化、应用和创新的阶段。她的作用已不是一种单纯的技术工具(手段),她的地位已不再是从属于某一学科的“附庸”,她已与地质、钻探一起成为找油气工作中的三大技术支柱。今天如果忽视其作用,降低其地位就会给找油气工作带来难以估量的影响,甚至会导致工作停滞不前。因此继续重视和加强石油物探工作应当是我国今后整个找油气工作的一个重要方针。

本文集能够出版是与石油工业出版社的关心与支持分不开的;张庭祺同志承担了全部中文编辑工作,王宝祥同志完成了高水平的全部英文翻译和英文编辑工作,他们为文集付出了辛勤劳动,保证了文集的出版质量,张鼎南同志对文集中的彩图印刷给予了无偿的支持,使文集增辉;陆基孟同志为文集写了一篇很好的序,是对我的一种鼓舞。为此我对他们表示衷心的感谢和诚挚的敬意。

最后借此机会,我要感谢数十年来在工作中与我一起奋斗的

同志和朋友们,如果没有他们的合作,我在石油物探工作中将一事无成。

我要感谢我的老师傅承义教授,是他把我引进地球物理这个诱人的领域,给我以启蒙知识。

我要感谢与我相濡以沫的妻子高陶。没有她为我默默地承受生活的重担,给我精神上巨大的支持,我相信也就不可能有今天的集子。

欧庆贤

1995年4月于南京



## INTRODUCTION

**Dedicated to all the Chinese doodlebuggers working on all fronts.**

Primarily this book is attempting to give an impetus to help propel forward our petroleum geophysical prospecting work for the future rather than a recollection.

The technological advancement of petroleum geophysics is found basically synchronous with the development of the new global high-technology in terms of their growth rate. Of late decade or so, the operation of geophysical prospecting for petroleum has been seemingly growing downwards. As a matter of fact, we are redoubling our efforts for providing quality assurance, or best professional services. This reflects the needs of its growth and the existing complexities/circumstances, and reveals a truth that oil and gas industry is dependent on oil geophysical prospecting technique. The petroleum geophysics has not only become the sole technical texture, state, composition and movement of the Earth's crust but also it is carrying within itself a science of petrogeophysics which is similar to petroleum geology. Definitely, the combination of the two will be greatly contributive to the expansion of petroleum industry.

It is about only one hundred years old that petroleum has be-