国家重点基础研究发展规划项目“大规模科学计算研究”第三课题

油藏模拟与波动问题及其反问题计算
课题结题总结报告

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石油工业中的大规模科学工程计算

- **科学工程计算在石油勘探和生产中极为重要**
  - 油藏模拟：在高性能计算机上数值模拟油田在开采过程中的石油，天然气在油藏中的复杂流动过程，以了解和控制油气田开采动态，为控制和选择优化的开发方案提供科学依据。

    发展精细油藏数值模拟技术，对我国相当部分已进入高含水油田后期剩油开采尤其有重要意义。

石油工业中的大规模科学工程计算

科学工程计算在石油勘探和生产中极为重要（续）

- 石油地震勘探：利用地震勘探中地面接收到的信息，经过对这些数据的数学处理，使地下构造成像和估计地层的石油物理参数。它为地下油气藏可能的位置提供科学依据，提高勘探的成功率。
- 油气盆地模拟：在计算机上模拟油气盆地沉积发育的地质过程，描述油气运移和聚集的历史。对评估油气资源有指导意义。

石油工业中的大规模科学工程计算

- **立项时的状况与需求**
  - 精细油藏模拟实际需要百万量级网格点，历时20年以上。作为生产需求，希望八小时内完成。

“九五”末期主要靠引进并行机和商业并行软件，费用高，且难以满足油田高含水后期剩余油精细描述的要求。Power Challenge上串行计算大庆百万节点问题，需要两个月以上时间才能完成。

石油工业中的大规模科学工程计算

立项时的状况与需求（续）

- 三维精细地下构造成像的地面原始数据在10^{10}量级，需要将该数据量向地下延拓几百步，以取得地下构造图象。

  1998年底中科院计算数学所刚建立36个节点的机群，刚实现了二维地下构造成像

- **石油工业对计算机的最高需求均是为了适应以上计算问题的需要**

课题预期目标

- 1999年本项目启动时本课题的目标：
  - 发展高精度，高分辨率，高效的油藏模拟计算格式，研制高效的并行求解器。预期在五年内通过算法改造和并行加速使计算快两个数量级。在地震勘探计算中，预期五年内通过算法改造将完成三维叠前偏移差分法的算法研究与并行实现，并为石油地质部门提供可应用的核心程序。

完成任务情况 — *油藏模拟数值计算*

- 完成了并行预条件子算法的研究，提出了由八种不同性质预条件组成的并行预条件子算法，并应用于油藏数值模拟软件
- 改进了原研制的PRIS并行模拟软件的算法与性能
- 新算法提高计算性能约1600倍 ，其中机器主频加速5倍，64个节点的加速不超过64倍 ，非线性问题求解器加速效果至少5倍

完成任务情况 — *油藏模拟数值计算*

- 实际数据：大庆116万网格点的数据，在LSSC-II上用64节点运行我们研制的并行软件，模拟一次用时仅为0.94小时

  比较：1998年在PowerChallenge上，用商业串行软件运行同样数据，一次模拟历时2个月以上

  比较：2001年在SGI2000上用8个处理器运行PVIP 2000商业并行软件模拟同一组数据，一次模拟时间超过70小时

完成任务情况—*波动方程三维叠前深度偏移*

- 改进了原已存在的混合法，Fourier差分法等
- 提出了创新的螺旋差分格式和多方向分裂方法等
- 建立了更为完善的单程波方程及保真振幅的波动方程偏移方法

完成任务情况—*波动方程三维叠前深度偏移（续）*

- 通过分炮线分区域计算，解决了大数据量存储和通讯困难，研制完成了MPI并行程序；

  在LSSC-I上对SEG/EAGE模型用50个节点完成了计算，用时三天，效果与国际上结果相当。

- 核心程序已提供有关石油部门作进一步开发

完成任务情况—*油气盆地模拟计算*

- 和胜利油田合作，已完成“多层油资源运移聚集高精度并行计算数值模拟软件系统”，模拟网格尺寸已从以前千米级降至200米，节点个数从万个数量级提高到百万个数量级，模拟时间长达3000万年，达到石油地质勘探的要求

完成任务情况—*基础研究*

- 对多维双曲型守恒律方程设计了一种非结构网格上的非线性守恒型有限元格式，证明了在一般网格下，收敛于初值问题的熵解
- 完成了非对称线性方程组迭代算法与理论研究。得到了一类能有效求解鞍点线性方程组的预处理HSS算法，得到了非对称线性方程组的NSS算法和PSS算法，证明了算法收敛性，取得很好的计算结果

完成任务情况—*基础研究*

- 完成了非线性问题多层迭代校正法和p-Laplace 的一致收敛性方法研究
- 进行了Euler和Navier-Stokes方程组的多尺度解数学模型和数值方法研究，发展了多尺度展开和均匀化理论，系统刻画了雷诺张量中大尺度和小尺度互动结构，在理论上搞清楚大尺度和小尺度互动的机理，建立工程上实用的大尺度模拟模型和数值方法

对项目总体目标的贡献

- 本课题是项目的第三课题，是项目中明确的三大应用目标（环境，材料，能源）之一。
- 超额完成了任务书中针对石油工业中的主要计算问题提出的具体研究内容。

（“完成任务情况”中已叙述）

对项目总体目标的贡献（续）

- **对项目任务书中共性问题提出的研究内容作出贡献**
  - 任务书四.2 款列出另一主要研究内容：“本项目将针对几个重要的科学工程领域出现的各类复杂的非线性偏微分方程组，创造并发展一批高性能的数值计算方法并在高性能计算机上实现，进行理论分析及数值实验，推动算法的应用。……，提出新的，可扩展的并行计算方法，研究科学计算可视化，为发展具有中国知识产权的大规模科学工程软件系统奠定基础。……，推动国产并行计算机的发展。”

对项目总体目标的贡献（续）

- 本课题组的主要贡献有:
  - 精细油藏模拟网格规模达500多万，相应的非线性方程组的阶数达1600万阶。
  - 研制解大型非线性方程组数值并行求解算法，形成并行解法器软件PRIS(Parallel Reservoir Integrated System)。
  - 在对流扩散方程、波动方程、Navier-Stokes方程，以及各类方程组合方面，研究其数值方法，发展有效的迭代法，在高性能计算机上的实现，进行了理论分析及数值实验。

对项目总体目标的贡献（续）

- **探索了我国专职科研部门与应用科研部门在国家基础研究项目(973)层面上科研合作的有效途径**
  - 应用部门提出需求并提供实际数据
  - 科研部门面向高性能并行环境研制有自主版权的核心算法或程序
  - 用项目或课题的形式进行联合调试
  - 应用部门进行二次开发和行业推广

研究水平与创新点

- **获得国家级、省部级奖励**
  - 《高性能分布式并行数值代数软件研究与开发》获2000年国家科技进步奖二等奖（第一完成人孙家昶，第四完成人曹建文，第十完成人潘峰）
  - 《能源数值模拟的理论和应用》获2002年国家教育部自然科学奖一等奖（第一完成人袁益让）
  - 《微机机群并行模拟技术研究》获2003中国石油天然气集团公司技术创新二等奖（第二完成人赵国忠）
  - 《混合有限元高效算法及其在油藏数值模拟中的应用》获2004年湖南省科技进步二等奖（第二完成人黄云清）

研究水平与创新点（续）

- **取得的研究成果已为国内外同行所承认**
  - 2004年8月5－7日的“石油工业中的科学计算”国际会议，与会者一致认为，这次会议学术水平高，组织成功，决定把这次国际会议序列化（45分钟大会报告11篇，30分钟特邀报告13篇）

研究水平与创新点（续）

- **有关专家对我们的部分工作做出书面评价如下：**
  - 由“实际数据驱动”的项目的价值超过“纯学术驱动”的项目
  - 在保振幅地震成像理论上的贡献在地震勘探学界是有名的，它们正日益增多地被应用于实践
  - 特别的贡献：引入了一个复杂的预条件子格式
  - 相应的高效并行软件开发的工作是世界级的
  - 中科院的软件包是当今国际上最先进最实用的软件包之一

研究水平与创新点（续）

- **改进了油藏模拟的并行软件及解法器，并在实际中应用推广**
  - 引入了有效的并行预条件子格式 ，计算结果表明其具有好的加速性能与并行性能。
  - 率先推出分布式油藏模拟并行软件，并在PC-Cluster上实现
  - 实际计算能力已达到五百万网格点，在64个处理器上模拟只需12小时

研究水平与创新点（续）

- **完成了波动方程叠前深度偏移的计算方法的研究**
  - 研制了波动方程混合法叠前深度偏移MPI并行程序
  - 完成了对SEG/EAGE模型数据的大规模计算
  - 提出了螺旋差分格式，减少数据传输与存储转换，节省了机时。提出的多方向分裂方法，克服数值格式引起的各向异性，改进成像质量
  - 真振幅波动方程叠前深度偏移方法是首创性的，用波动方程因子分解，声波波场上下行波分裂等思想导出了单程波方程新的更为完善的形式

研究水平与创新点（续）

- **油气盆地数值研究在数学模型，数值方法和理论分析方面有开创性**
  - 在非线性多层渗流方程耦合系统，可压缩二相渗流驱动问题分数步方法，迎风格式和非矩形区域多组分特征方向有限元方法等均取得重要成果。
  - 已应用于油气资源评估和环境科学实际工程计算，产生巨大的经济和社会效益。

研究水平与创新点（续）

- 应隆安在非结构网格上多维双曲型守恒律方程的有限元方法，熵方法及燃烧等方向做出了一批高水平的工作。
- 白中治设计了求解正定但非对称线性方程组的实用而有效的对称/反对称分裂迭代算法（HSS），建立了这类算法的收敛理论。这方面的研究成果已发表在数值代数的国际核心杂志上。

研究水平与创新点（续）

- 黄云清等利用单位分解来“粘结”不同的子空间，成功的解决了非匹配网格上的有限元问题；将多层线性化与Cascade迭代有机结合，设计的“多层逐次迭代法”使得求解非线性问题可以在几乎最优的工作量下完成；对于p-Laplacian 问题，通过在新的空间意义下求出的最速下降方向（相当于对经典意义下的最速下降法进行某种预处理），得到了一种与网格规模无关的迭代算法，极大的改善了此类问题的求解效率。

研究水平与创新点（续）

- 羊丹平通过发展多尺度展开和均匀化理论，发现了一些大尺度和小尺度互动的关系，在理论上已经取得了系统的分析结果。
- 孙家昶提出了“非传统结构化网格”概念。对二维三向网格及三维四向网格，建立了相应广义Fourier变换，Fourier级数等较系统的理论；在数学上已推广到任意高维情况，实现了相应非张量积区域上的快速算法，推出了公开并行软件包FFTH。

应用效果

- 提供给国内三大石油公司CNPC, SinoPEC和CNOOC“机群系统+并行模拟”软硬件一体化系统，推广了大规模油藏模拟并行计算、机群搭建、软硬件一体化模拟等技术。
- 协助胜利油田地质科学院在神威计算机上运行了一系列140万网格点的实际数据。

应用效果（续）

- **大庆研究院形成了自己的专用油藏模拟软硬件一体化系统，在七个采油厂进行推广应用，取得了显著的效益：**
  - 实现了与微机机群大规模并行模拟技术的综合集成，形成了大庆油田高含水后期多学科油藏研究的工作环境和平台。
  - 先期投入研究的油藏区块步入生产动态跟踪模拟，提高了工作效率，降低了操作成本。油田大规模油藏数值模拟，已成为剩余油精细预测和高效挖潜的关键技术之一。

应用效果（续）

- 山东大学和胜利油田合作，完成了“多层油资源运移聚集数值模拟系统”，使得模拟的网格尺寸从千米级降至200米，节点个数从万数量级提高到百万数量级，模拟时间长达 3000万年。应用该系统对东营、沾化地区进行数值模拟，在“郑家——王庄油田”区域，发现了亿吨级大油田。

预期解决国家重大需求的实质性贡献

- 研制了油藏数值模拟、三维叠前偏移、多层油气盆地数值模拟的并行软件和核心程序，改善了进口相应软件的局面。
- 大庆油田综合研究认为基于大规模油藏数值模拟技术的应用来预测和挖潜剩余油，可提高采收率0.5□ 1.0%。对大庆油田已开展研究的油藏区块，按提高采收率0.5%计算，将多产原油314万吨。具有巨大的潜在经济效益。

研究队伍与人才培养

- 骨干10名，一般人员10名，博士后，学生16名；中期评估后调整为骨干11名，一般人员4名，博士后，学生9名
- 在本课题参加人员中，以下中青年骨干作出突出成绩，获得国家级、省部级奖励：
  - 黄云清获2002年教育部跨世纪人才基金，获2004年湖南省科技进步奖二等奖（第二完成人）
  - 曹建文（第四完成人）、潘峰（第十完成人）获2000年国家科技进步奖二等奖
  - 赵国忠2003年获大庆油田技术创新突出贡献奖，中国石油天然气集团公司技术创新奖二等奖（第二完成人）

数据共享与技术资料归档情况

- 课题组每年举办一次学术讨论会议，邀请其它课题组人员参加，研究资料相互共享。
- 本课题组的油藏数值模拟并行计算，提供作为Benchmark之一，参加了LSSC-II、DeepComp6800的测试与调试、调优工作。
- 并行执行程序，微机机群的搭建、定制标准等技术信息提供给了大庆勘探开发研究院、胜利石油管理局和中海石油研究中心。

数据共享与技术资料归档情况（续）

- 为胜利油田地质科学院成功地在神威高性能计算机上运行了他们提供的140万网格点实际数据的油藏模拟计算。
- 有关软件形成了相应的文档。若干比较成熟的计算程序已经或者即将放在相关网站上，作为public domain软件。

数据共享与技术资料归档情况（续）

- **文档举例：**
  - 《大规模油藏数值模拟并行应用研究项目文档》
  - 《微机机群油藏数值模拟并行软件
  - PRIS1.0 使用说明》
  - 《微机机群油藏数值模拟并行软件
  - PRIS1.0 设计方法》
  - 《微机机群油藏数值模拟并行软件
  - Linux机群基础培训》
  - 《MPI并行混合法三维叠前深度偏移核心软件》

经费使用情况

- 2000年－2004年8月

  收到大项目组拨来经费421.8万元。

  全组共支出309.7万元。

存在问题与不足

- 将研究成果与行业应用相结合是重要的，但结合的难度很大，成果转化周期太长。尽管我们课题组在这五年内尽了极大努力，也得到应用部门的好评，但还只是在典型应用的阶段。
- 研究成果与行业应用的结合是一项长期的工作，需要多方面的支持，稳定队伍。目前还没有稳定队伍的有力措施。

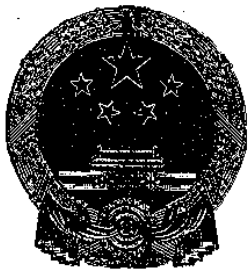
存在问题与不足 （续）

- **原因是多方面的：**
  - 国家科技政策导向
  - 科研评价体系
  - 科研人员的观念

第三课题

油藏模拟与波动问题及其反问题计算
课题结题总结报告

附 件



国家科学技术进步奖

证 书

为表彰国家科学技术进步奖获得者，特颁发此证书。

项目名称：高性能分布式并行数值代数软件研究与开发

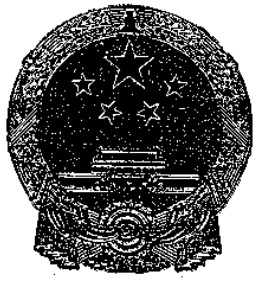
奖励等级：二 等

获 奖 者：中国科学院软件研究所

中华人民共和国国务院

2001年1月3日

证书号：J-220-2-06-D01



国家科学技术进步奖

证　书

为表彰国家科学技术进步奖获得者，特颁发此证书。

项目名称：高性能分布式并行数值代数软件研究与开发

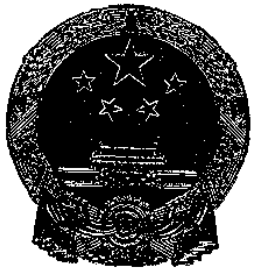
奖励等级：二　等

获 奖 者：孙家昶

中华人民共和国国务院

2001年1月3日

证书号：J-220-2-06-R01



国家科学技术进步奖

证 书

为表彰国家科学技术进步奖获得者，特颁发此证书。

项目名称：高性能分布式并行数值代数软件研究与开发

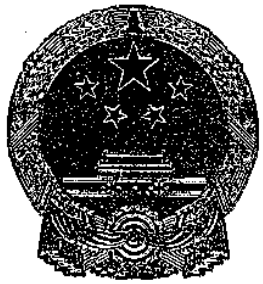
奖励等级：二 等

获 奖 者：曹建文

中华人民共和国国务院

2001年1月3日

证书号：J-220-2-06-R04



国家科学技术进步奖

证　书

为表彰国家科学技术进步奖获得者，特颁发此证书。

项目名称：高性能分布式并行数值代数软件研究与开发

奖励等级：二　等

获 奖 者：潘　峰

中华人民共和国国务院

2001年1月3日

证书号：J-220-2-06-R10

为表彰在促进科学技术进步工作中做出重大贡献，特颁发此证书。

获奖项目：能源数值模拟的理论和应用

获 奖 者：袁益让　（第1完成人）

奖励等级：一　等

奖励日期：2003年01月

证 书 号：2002-027

二〇〇三年一月二十日

ICIAM 2003
5th International Congress on
Industrial and Applied Mathematics
SYDNEY, AUSTRALIA 7-11 JULY 2003

Reply to: Professor I.H. Sloan
School of Mathematics
University of New South Wales
UNSW SYDNEY NSW 2052
Australia
E-mail: i.sloan@unsw.edu.au
Fax: +61-2-9385 7123

May 29, 2001

Professor Long-an Ying
Peking University, China

Dear Professor Ying,

re: Invitation to speak at ICIAM 2003

On behalf of the Organising Committee for ICIAM 2003 (the fifth International Congress on Industrial and Applied Mathematics, to be held in Sydney from July 7–11 2003) we are delighted to be able to invite you to play a major part in the Congress in the role of invited speaker.

The invited speakers (numbering approximately 27) come from every part of applied mathematics. They have been chosen by the International Program Committee through a rigorous selection process. Their names will be announced publicly in the third quarter of this year, and given considerable prominence in the leadup to the Congress.

As an invited speaker at the Congress, you will receive five nights free accommodation at an appropriate hotel in company with our other invited speakers. You will also receive free registration, and an economy class return airfare to Sydney if you need it (we recognise that some of our invited speakers already have an adequate travel budget to meet air fares). In return, there is an expectation that you will attend the full five days of the Congress and provide a written paper related to your talk, as explained in the enclosed guidelines. The written version (to be published by SIAM after the Congress, and in CD form at the time of the Congress) is needed 10 weeks before the Congress. Invited speakers are asked to recognise the importance of adhering to this timetable.

We mention that our gold or silver sponsors may wish to sponsor one or more named invited speakers, as part of the financial agreements that will underpin the Congress. You can be assured that if such a question arises in your case we shall seek your agreement before approving any such arrangement.

We sincerely hope that you will be able to accept this invitation, and that you will be able to do so promptly, or at least within one month. If for some reason you are unable to give an answer within this time then we would ask you to acknowledge receipt promptly, and perhaps indicate the nature of the problem.

Please reply, by e-mail, fax or mail, to Ian Sloan at the address above.

Yours sincerely,

Noel Barton

Dr Noel Barton
Director, ICIAM 2003

Ian H. Sloan

Professor Ian H. Sloan
Chair, International Program Committee

ICIAM 2003
is organised by
ANZIAM (Australian and New Zealand Industrial and Applied Mathematics)
for the
Committee for International Conferences on Industrial and Applied Mathematics

CICIAM

INVITED SPEAKERS

was full professor at the Delft University of Technology. Early in 1991 he co-authored Solving Linear Systems on Shared Memory Computers with Dongarra, Duff and Sorensen. This book was reprinted in 1993, and has been translated into Japanese. A follow-up was published in 1998. More recently he proposed the now popular Bi-CGSTAB method (1992), and, together with Vuik, the class of GMRES methods (1994), that admit variable preconditioning in a robust way. The paper on Bi-CGSTAB was the most cited paper in mathematics written in the 1990s (ISI). For a joint paper with Sleijpen on Jacobi-Davidson methods for eigenvalue problems (1996), he received the SIAG/LA Prize in 1997. In 1994 he co-authored Templates for Linear Systems, including Preconditioning. This book has been rather influential in standardising algorithms; most of the templates have been included in MATLAB. A similar book on eigenproblems appeared in 2000. All together he has (co-)authored over 100 publications. He is (associate) editor of seven journals related to scientific computing, including SISC, JCAM, APNUM, and Parallel Computing.

Ying Lung-an, Beijing University, People's Republic of China

Ying Lung-An is professor of the School of Mathematical Sciences of the Beijing University. In his 41-year research career, his interests have been in nonlinear partial differential equations and numerical methods for partial differential equations. He has published four books and 84 papers in this area, including work on finite element methods, hybrid finite element methods, vortex methods, inhomogeneous systems of hyperbolic conservation laws, combustion theory, numerical schemes for conservation laws, and interface problems. Professor Ying was born in Beijing and graduated at the Beijing University in 1960. He was within the first group of 52 visiting scholars from the People's Republic of China to the United States of America in 1978. He has been awarded 14 prizes, including the Award of the Chinese National Conference of Science, the National Prize on Natural Science, the National Prize for the Accomplishments of Education, the State Education Commission's Prize for the Advancement of Science and Technology, and the Pei-yuan Chou Prize. He was the chairman of the Department of Mathematics, Beijing University, 1991-1995; president of the Beijing Computational Mathematics Society, 1990-1993; vice president of the Chinese Computational Mathematical Society, 1991-1998; and since 2000 the chief editor of Advances in Mathematics (China).

Vladimir Zakharov, University of Arizona, Tucson, USA

Since 1992, Vladimir Zakharov has been Director of the Landau Institute of Theoretical Physics, one of the top research institutions in theoretical physics in the world. Also Zakharov is Professor of Mathematics at the University of Arizona, Tucson. Among his research interests are weak turbulence, optics, solitons, singularities, field theory, characterisation of integrable systems, strong turbulence, and general relativity. Professor Zakharov is well known for his fundamental contributions to numerous areas of mathematics and physics. A partial list of his discoveries includes the method of inverse scattering for completely integrable systems, the Hamiltonian formulation for water wave mechanics, and the kinetic theory approach to turbulence. He received his PhD from the Budker Institute for Nuclear Physics, Novosibirsk, and is a member of the Russian Academy of Sciences.

Timetable at a Glance – Morning Sessions

	Monday, 7 July	Tuesday, 8 July	Wednesday, 9 July	Thursday, 10 July	Friday, 11 July
0845-0930 invited talks (three at a time, except for Monday, when there are two at the same time)	0845 Opening Ceremony Her Excellency, Prof Marie Bashir Prof Olavi Nevanlinna (President of the International Council) Dr Noel Barton (ICIAM 2003 Director) Including presentation of ICIAM Prizes: ICIAM Lagrange Prize ICIAM Collatz Prize ICIAM Pioneer Prize ICIAM Maxwell Prize	Jennifer Tour Chayes, USA *Phase Transitions in Combinatorial . Optimization* David Donoho, USA *Geometric Multiscale Analysis and its Applications.* John Holt, Opcom Pty Ltd *Operations Research in Travel and Transport*	Yann Brenier *Optimal Transportation Theory via Geometric Partial Differential Equations.* Harald Niederreiter, Singapore *High-Dimensional Numerical Integration.* John Martin (ABN AMRO) Stephen Chambers (Axiss) *Australia's place in global financial services and the role played by mathematics*	Brian Anderson, Australia *Pulling the Information out of the Clutter.* Hillel Furstenberg, Israel *Nonconventional Ergodic Averages, Nilpotent Groups, and the Long Term Memory of Dynamical Systems*	Franco Brezzi, Italy *Stability Revisited.* Philippe Toint, Belgium *How Mature is Nonlinear Optimization?*
0930-1015 invited talks (three at a time, except for Thursday and Friday)	Yoshikazu Giga, Japan *Singular Diffusivity – Facets, Shocks and more.* Nancy Kopell, USA *Rhythms of the Nervous System – Biophysics and Dynamical Structure.* Hendrik Lenstra, The Netherlands *Primality Testing with Pseudofields*	Marsha Berger, USA *Putting Together the Pieces: Grid Generation and Flow Solvers for Complex Geometries.* Alexander Mielke, Germany *A New Approach to Elastoplasticity using Energy and Dissipation Functionals.* Charles Fefferman, USA *Unsolved Problems of Fluid Mechanics*	Mark Davis, UK *Valuation, Hedging and Investment in Incomplete Financial Markets.* Peter Deuflhard, Germany *New Math for New Drugs against New Diseases.* Michael Ortiz, USA *Variational Problems in Mechanics and the Link between Microstructure and Macroscopic Behavior.*	Vladimir Zakharov, Russia *Analytical Study, Numerical Simulation, and Modelling of Wave Turbulence.* Jim Moffat, UK *Modelling Information Age Warfare: Remaining Challenges.*	Tom Hou, USA *Multiscale Modelling and Computation of Incompressible Flow.*
1015 – 1100	Refreshments	Refreshments Poster Displays	Refreshments Poster Displays	Refreshments Poster Displays	Refreshments
1100 – 1300 parallel sessions (minisymposia and contributed talks)	Parallel Sessions (43 in all) ICIAM ANZ Convention CTAC	Parallel Sessions (43 in all) ICIAM ANZ Convention CTAC ASOR	Parallel Sessions (43 in all) ICIAM ANZ Convention CTAC NSFM ASOR	Parallel Sessions (43 in all) ICIAM ANZ Convention EMAC NSFM ASOR	Parallel Sessions (43 in all) ICIAM ANZ Convention EMAC

Timetable at a Glance – Afternoon Sessions

	Monday, 7 July	Tuesday, 8 July	Wednesday, 9 July	Thursday, 10 July	Friday, 11 July
1400-1415 *Prizes*		Henrici Prize (before van der Vorst talk)		Wilkinson Prize (before Demmel talk)	
1415-1500 (except Friday) invited talks (three at a time)	Tom Leighton, USA *The Challenges of Delivering Content and Applications on the Internet.* Ernie Tuck, Australia *Computation and Minimisation of Ship Waves.* Cheryl Praeger, Australia *Computers in Algebra: First came Answers, and then more Questions*	Jonathan Keating, UK *Random Matrices and the Riemann Zeta Function.* Peter Markowich, Austria *Highly Oscillatory PDEs.* Henk van der Vorst, Netherlands *Iterative Solution Methods: Tools, Aims, Craftmanship.*	Alice Guionnet, France *Aging in Particle Systems.* Rupert Klein, Germany *An Applied Mathematical View of Meteorological Modelling.* Wilfried Schmid, USA *How much Mathematics in Mathematics Education?*	James Demmel, USA *Accurate and Efficient Algorithms for Floating Point Computation.* George Papanicolaou, USA *Imaging, Communications and Time-Reversal.* Ying Lung-an, China *Interface Problems and their Applications.*	1400-1600 Parallel Sessions (43 in all) ICIAM ANZ Convention EMAC
1500-1530 (except Friday)	Refreshments	Refreshments	Refreshments	Refreshments	1600-1615 Refreshments
1530-1730 (except Friday) parallel sessions (minisymposia and contributed talks)	Parallel Sessions (43 in all) ICIAM ANZ Convention CTAC	Parallel Sessions (43 in all) ICIAM ANZ Convention CTAC ASOR	Parallel Sessions (43 in all) ICIAM ANZ Convention EMAC NSFM ASOR	Parallel Sessions (43 in all) ICIAM ANZ Convention EMAC NSFM ASOR	1615-1645 Closing Ceremony

Grey shading indicates timetable features associated with Embedded Meetings or non-ICIAM prizes.

Special Days/Events

Sunday, 6 July 1500-1700: Career Development Workshop (how-to workshop for early career delegates)
Tuesday, 8 July: Industry Day, featuring a set of eight Special Technological Workshops
Wednesday, 9 July: Education Day, featuring lectures, exhibits and, by arrangement with Claxton Communications, Adam Spencer
Thursday, 10 July: Community Day, featuring lectures, exhibits and from 1800-1900: Helaman and Claire Ferguson "Mathematics in Stone and Bronze."

Social Events

Sunday, 6 July, 1730-1930: Icebreaker Reception, The Powerhouse Museum
Monday, 7 July, 1800-2000: Welcome Reception, Bayside Banquet Hall
Tuesday, 8 July, 1900-2300: VIP Dinner, Strangers' Dining Room, Parliament House
Wednesday, 9 July: Night at the Opera, 1930, Opera Theatre; Proof, 1930, Drama Theatre, Sydney Opera House
Thursday, 10 July: Harbour Cruise, 1930-2300

Social Events for Embedded Meetings: contact the representatives for the relevant Embedded Meeting.

山东省科学技术奖

证 书

为表彰山东省科学技术奖获得者，特颁发此证书。

项目名称：多层油资源运移聚集定量数值模拟技术研究

奖励等级：叁　等

获 奖 者：袁益让（第贰位）

类　　别：科技进步奖

2003年11月

证书号：K2003-3-140-2

科学技术进步成果奖证书

项目名称：多层油资源运移聚集定量数值模拟技术研究

获奖等级：一等奖

完成单位：物探研究院

完 成 者：袁益让　　（第 2 完成人）

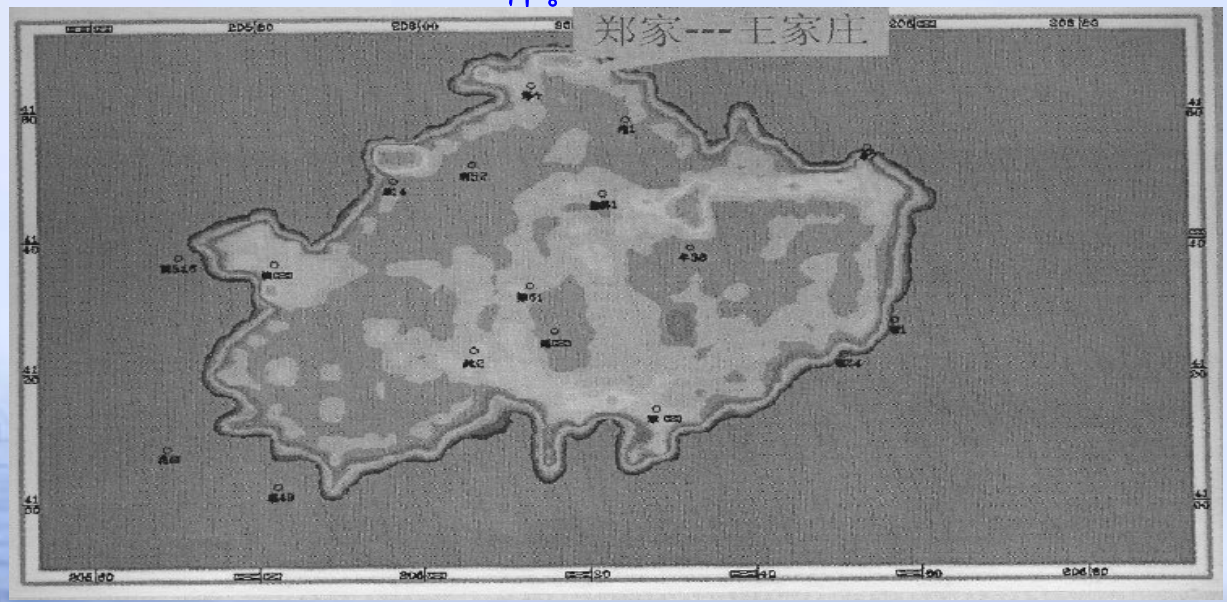
奖励日期：2002年 8 月

证 书 号：0101302

胜利石油管理局科学技术委员会

2000-2001年对东营地区数值模拟结果给油田勘探部报告

- 郑家—王庄潜山披覆带，是今后勘探的重点地区
- 如果该地区具备有利的储盖组合，则可以形成有效的正常油藏；如果该地区不具备有利的储盖组合，那么该地区也是稠油的有利勘探区域。总之，只要在该地区增加勘探力度，相信会有重大突破。
- 从本次模拟结果来看，油资源运移的一个重点方向是郑家—王庄油田，而且局部含油饱和度的最大值在0.7，是该地区油资源运移聚集的最高值，同时，该地区又是油资源运移的重要逸出点之一，由此可以预测郑家—王庄油田及其附近地区，具有形成有利圈闭的油资源条件。



(附件3)

胜利日报

SHENGLI RIBAO

2002年10月23日　星期三　第5513期

胜利石油管理局主办　国内统一刊号 CN37-0012

东营凹陷北部显现亿吨级稠油大油田

本报讯（通讯员 宋国满 王大华 阎毅）一个亿吨级规模的大型整装稠油油田已经展现在我们面前。

截至目前，东营凹陷北部郑家王庄地区已经控制含油面积40平方公里，探明、控制和预测石油地质储量8435万吨，目前勘探范围还在进一步扩大。

郑家王庄地区地处东营凹陷北部陡坡带西段、陈家庄凸起西段的南缘。20年前在单家寺油田扩边勘探时，发现了郑家和王庄两个小型稠油油田，分别控制石油地质储量为611万吨和799万吨。由于该区原油较稠，受当时工艺技术条件和地质认识水平的限制，多数井试油试采效果不理想，勘探工作一度陷入困境。1993年以来，我油田利用三维地震资料精细落实目的层段及其构造，先后部署了一批评价井，同时采用注蒸汽吞吐，使该地区单井稠油产量得到提升，分别探明石油地质储量769万吨和600万吨。但由于郑家王庄地区地质条件复杂，油藏隐蔽，该区的勘探多年没有取得大的突破。

近两年来，地质研究人员突破老框框，建立了新的成藏组合体模式，通过大力强化基础性课题研究，认为该区地貌古冲沟长期继承性发育，具有形成多层系叠合连片砂砾岩群的沉积条件，与南部注陷有效源岩体沟通良好，油源充足。在新的地质认识指导下，利用新的三维地震地质综合解释资料，今年油田部署的郑36和郑斜41等5口探井，钻探均获成功，常规测试均获得工业油流。其中郑斜41井电测解释油层11层89.2米，沙一段电熟杆常规试油，获日产13吨工业油流。区块南部的坨82-斜1井钻遇油层厚度88米。

"东胜精攻杯"
头条新闻大赛

技术创新突出贡献奖

证　书

为表彰在油田技术创新工作中做出突出贡献的科技工作者，特颁发大庆油田有限责任公司技术创新突出贡献奖证书，以资鼓励。

获 奖 者：赵国忠

获奖日期：二〇〇三年四月

大庆油田有限责任公司

为表彰在促进石油天然气工业技术创新工作中做出重要贡献，特颁发此证书，以资鼓励。

集团公司技术创新奖

奖励证书

获奖项目：微机机群并行模拟技术研究

获 奖 者：赵国忠(第2完成人)

获奖等级：二等奖

中国石油天然气集团公司

二〇〇三年七月

证书号：2003年一二等一38一GR一02

Comments on Jianwen Cao talk

The talk summarizes the development of scalable numerical algorithms, and the development of scalable parallel software in this project. I am extremely impressed with the project. Even though large scale computing is quite common in scientific research, it is still rare to see large computing projects, such as this one, using actual data, actual geometry and mathematical models with measured coefficients. In my opinion, this type of 'actual-data-driven' project is more valuable than many 'academic' projects.

One particular contribution is the introduction of a rather complex preconditioning scheme. The field of preconditioning techniques is mature for single physics problems, for multi-physics problems, it is still more of an art than science in the designing of a good preconditioner. From the computational results shown in the presentation, it looks like the right preconditioning techniques has been identified as a combination of seven preconditioners. Without a deep understanding of the physics, as well as the computing platform, it is not possible to come up with such a preconditioning scheme that performs so well on large meshes and machines with large number of processors. It would be nice if a more abstract preconditioning framework can be extracted from the current work so that one can treat other multi-physics problems using a similar approach.

The work in the development of efficient parallel software is also world-class. If I understand correctly, the overall codes consist of an old legacy program from an oil company, a modern parallel

code PETSc, and several other packages. To obtain such good performance, as shown in the presentation, the integration of the software packages, the interface design, and the data structures transformation have to be seamless. I believe the experience of the software integration is of great value to many other large scale software projects.

Xiao-Chuan Cai
Dept. of Computer Science
Univ. of Colorado at Boulder
Boulder, CO 80309-0430

BHI's Assessments on Dr. Cao Jianwen

Under an agreement between Baker Atlas GEOScience, a subsidiary of Baker Hughes Inc. (BHI), and the Chinese Academy of Sciences (CAS), a joint benchmark project was conducted in the year 2000. The purpose of the project was to evaluate the performance of a parallel linear solver developed by the Institute of Software, CAS, with BHI's leading commercial reservoir simulator, SimBest II.

Dr. Cao Jianwen was the team lead from CAS and responsible for conducting the benchmark tests. At the time, I was functioning as the product manager of SimBest II, and had a chance to work closely with Dr Cao and his team for about two months. The project was a great success. A comprehensive test runs were conducted on both shared and distributed memory systems. The test cases ranged for conventional black oil to extended multi-component systems. My group, SSI or Baker Hughes Software Company, was impressed by not only the technical results, but also the high standard and dedication that Dr. Cao and the team brought to us. As a result, the SSI group proposed and recommended the continuation of the collaborative project and a possible joint product release to the management of BHI. Unfortunately, BHI was in the re-organization process resulted from the merge between Baker Hughes and Western Atlas International. As a result, the project was delayed indefinitely.

At the time when the project was conducted in Baker's Houston office, there was one parallel reservoir simulator – the VIP-P on the market, and another one from Geoquest was ready to release. Based on the data from BHI's clients, who had accesses to these products, the benchmark results from Dr. Cao's team had noticeable advantages and showed nearly linear speedup ratios up to eight CPU's even without fine tune-up and adequate hardware support.

Though BHI got out of the market of commercial reservoir simulation – a business decision to maintain BHI's core, Dr. Cao's work had generated enough interests that our clients had encouraged BHI to return to the market with a release of parallel version of SimBest II.

In short, Dr. Cao's work on the continuous development and improvement of the parallel linear solver has a leading edge in the commercial reservoir simulation market. At BHI, we believe that the software package (solver) from CAS is one of the most advanced available, and Dr. Cao has the caliber of being a leader in this area.

Wei David Liu, Ph.D.
Sr. Research Scientist,
Houston Technology Center, Baker Atlas
Baker Hughes Inc.
2001 Rankin Rd. Houston, Texas 77073, USA
(713) 625-5343
Wei.Liu@BakerHughes.com
June, 30th, 2006

Beijing, August 6, 2004

To whomever it may concern:

It is with great pleasure that I write this letter supporting Prof. Guanquan Zhang's work.

I have known Prof. Zhang in person for over a year, but I have known his work for much longer. His contributions to the theory of preserved-amplitude seismic imaging are well known in the seismic-exploration community, and they are increasingly applied in practice. Furthermore, Prof. Zhang has educated several young Geophysicists that are beginning to make their own substantial contributions to the advancement of knowledge in our field.

The following threes specific contributions by Prof. Zhang stand out:

1. The development of a new version of the well-known, and widely used, one-way wave equation that matches the full two-ways wave equation not only in the kinematics but also in the amplitudes
2. The development, in collaboration with Prof. Norm Bleinstein, and Prof. Zhang's former student Dr. Yu Zhang, of an imaging process that utilizes Prof. Zhang's new one-way wave equation (item 1, above) to image seismic data preserving the reflector amplitudes, and thus enabling more accurate estimation of petro-physical parameters.
3. The education of several successful Geophysicists. In particular I know of two young Geophysicists that are already gaining respect in the Geophysical community.
   - Dr. Yu Zhang, a former Ph.D. student of Prof Zhang, who works in Houston for the well respected Geophysical contractor Veritas. The Society of Exploration Geophysicists (SEG) ha honored Dr. Yu Zhang with the SEG 2004 Karchner award for outstanding young Geophysicists. This award is given only to few (2-3 a year) promising Geophysicsts that have already made substantial contribution to the profession.
   - Mr. Guoijan Shan, a former Master student of Prof. Zhang, who is a third-year Ph.D. student of mine at Stanford University, and who has already distinguished himself as being one of the brightest Stanford's students in his generation.

In summary, I think that Prof. Zhang work as a researcher and as a teacher are outstanding, and deserve a strong support from the Chinese and international scientific community.

Biondo Biondi
Associate Professor (Research) of Geophysics
Stanford University

谢 谢 ！