

Supported By



Ω

3

μ

 \pm

П

Φ

α

0

δ

φ

ΜΑΤΗΕΜΑΤΙCAL ΜΣΤΗΟDS

FLUID DYNAMICS AND SIMULATION OF GIANT OIL AND GAS RESERVOIRS

3–5 SEPTEMBER 2012 Swissotel, Istanbul, Turkey

CONFERENCE PREVIEW

SCHEDULE OF **EVENTS**

0730-0845 hours Registration, Welcome Refreshments, Collection of Badges and Delegate Packs 0845-0900 hours Safety Moments and Opening Remarks from the Conference Chairman 0900-1030 hours Session 1: HPC Trends and Fast Solution Methods (Linear and Nonlinear) 1030-1100 hours Coffee Break 1100-1230 hours Session 1 Continued Luncheon 1230-1400 hours 1400-1530 hours Session 2: Multiphysics and Complex Model Challenges 1530-1600 hours Coffee Break 1600-1700 hours Panel Session: Spatial and Temporal Discretisation for Coupled Non-Linear PDEs 0900-1030 hours Session 3: Multiscale Modelling 1030-1100 hours Coffee Break 1100-1230 hours **Session 3 Continued** 1230-1400 hours Luncheon 1400-1530 hours Session 4: Reservoir Management, Optimisation, Inverse Problems, and Uncertainty Quantifications 1530-1600 hours Coffee Break 1600-1700 hours Panel Session: Challenges in Reservoir Simulation 0900-1030 hours Session 5: Large Scale Data Reduction/Compression, Mining, and Visualisation Coffee Break 1030-1100 hours 0900-1030 hours **Session 5 Continued** 1230-1400 hours Luncheon Session 6: Lessons in Large Scale Computing in E&P and Other Application Areas 1400-1530 hours 1530-1600 hours Coffee Break Panel Session: Exploitation of Nonhomogeneous Processing: Extreme Computing 1600-1700 hours Hardware and Software 1700-1730 hours Conference Summary and Close

WHO SHOULD ATTEND

Scientists from academia and industry, mathematicians, engineers, computational scientists, computer hardware specialists, and others interested in contributing to this subject.

Energy is a vital substance required throughout the world to maintain our current civilisation and advance further. A significant portion of our energy needs come from oil and gas. Giant oil and gas reservoirs of the Middle East and other regions contribute to a major portion of the world's hydrocarbon supply. Mathematical models in fluid dynamics and flow through porous media play a critical role in developing and managing these reservoirs.

Today, oil companies and universities work on highly sophisticated mathematical and computational methods describing multi-phase, multi-component fluid flow in reservoirs, pipe line networks, and surface separators. Numerical solutions of these highly nonlinear coupled partial differential equations require moderate to sophisticated computing platforms.

As giant fields mature, being able to utilise the vast amount of measured data with higher accuracy in simulators paves the road to recover more hydrocarbons and thus respond to the world's energy needs. This conference will gather mathematicians and engineers to address challenges in mathematical modelling of compressible multi-phase flow in porous media with reactions, fractured media, flow in pipes and pipe networks, coupled numerical solution of porous and non-porous media, geomechanics, diffusion, dispersion problems, unstructured grid generation, linear and nonlinear solvers, multi-grid methods, new discretisation methods, parallel computing, hybrid computing involving multicore CPUs and GPUs, scientific visualisation of large data, real field studies for giant oil and gas reservoirs using simulators.

INTERESTED IN SPONSORING OR EXHIBITING AT THIS EVENT?

If so, contact **Sween Rajan**, sponsorship and exhibits manager, at **srajan@spe.org** or call +971.4.457.5852.

COMMITTEE PROGRAMME HIGHLIGHTS

Ali Dogru, Saudi Aramco (Conference Chairman)

David Keyes, SIAM and KAUST (Co-Chairperson)

Mary Wheeler, University of Texas at Austin (Co-Chairperson)

Serdar Celebi, Istanbul Technical University (Co-Chairperson)

Andrey Gladkov, Modeling Technologies Center

Bret Beckner, ExxonMobil

Carol Woodward, Lawrence Livermore National Laboratory

Garfield Bowen, Schlumberger

Gregory King, Chevron

Hector Klie, ConocoPhillips

Joroen Vink, Shell

Kees Vuik, Delft University of Technology

Khalid Aziz, Stanford University

Klaus Stueben, Fraunhofer Institute

Knut Andreas Lie, SINTEF

Long Nghiem, Computer Modelling Group

Michel Kern, INRIA

Patrick Demichel, Hewlett Packard

Philippe Quandalle, IFP Energies Nouvelles

Philippe Thierry, Intel

Ruben Juanes, MIT

Shuong Wu, PetroChina

Ulisses Mello, IBM

Vasilii Shelkov, Rock Flow Dynamics

Session 1: HPC Trends and Fastreacting and non-traditSolution Methods (Linear and Nonlinear)porous media with part

Session Chairs: **David Keyes**, SIAM and KAUST; **Kees Vuik**, Delft University of Technology

A primary challenge for reservoir simulation is the accurate description of multiphase flow in porous, highly heterogeneous, and fractured media with very complex geometries. The lack of robust and efficient solvers for fully implicit formulations is still one of the main bottlenecks that most simulator developers face in the oil and gas industry. Generally, the underlying systems of partial differential equations are nonlinear, highly non-symmetric, and indefinite. The condition number and degree of coupling of these systems may be subject to dramatic changes due to abrupt flow variations induced by the highheterogeneity and complex well operations during the simulation process. In addition, over recent years, reservoir models have been growing in complexity (regarding geometry, discretisation and physical models including, for instance, thermal and chemical influences, geomechanics), heterogeneity, and size, causing these systems to get increasingly large and difficult to solve. In fact, the computational time required to solve these systems of equations is today's major bottleneck in the practicability of numerical simulation. Hence, advanced reservoir simulators need to combine the numerical scalability (optimality) of efficient solvers with the parallel scalability of modern hardware. This session addresses the efficient use of parallel architectures (including both, large scale clusters of conventional x86 multi-core CPUs as well as heterogeneous systems equipped with hardware accelerators, e.g. GPUs), and all relevant numerical aspects such as the treatment of linear and nonlinear problems, treatment of fully coupled systems (either the Jacobian directly or by CPR-type approaches), efficient preconditioning techniques, and fast linear solvers (hierarchical solvers such as multigrid or multilevel ILU).

Session 2: Multiphysics and Complex Model Challenges

Session Chairs: Bret Beckner, ExxonMobil; Michel Kern, INRIA

This session seeks to present challenges and solutions to problems associated with

reacting and non-traditional fluid flows in porous media with particular emphasis on application in computational large models. Topics of interest include:

- Challenges and solution methods for modelling reactive transport in porous media. Examples include models for porous media dissolution and/or deposition, induced wettability alteration, salinity effects on EOR and water flooding.
- Modelling of localised, small scale phenomena within reservoir simulation grid blocks. Many important processes occur over length and time scales below that of a typical reservoir simulation. Modelling of combustion and solvent fronts, coupled wellbore flow and near well-bore flows such as fine migration and hydraulic fractures are examples.
- Integrated and efficient modelling of coupled geomechanics and porous media flows
- Advanced methods in compositional reservoir simulation including aggregation methods for large multi-field, multi-fluid systems, fast and robust algorithms for multi-phase, non-isothermal flash calculations, and new methods for phase equilibrium calculations for hydrocarbon/ water/CO₂ systems.
- Modelling flows in large unconventional gas and oil deposits including modelling multi-phase dispersion and diffusion effects as well as models for CO₂ sequestration.
- The simulation of coupled models presents specific challenges in addition to those already found in the individual models. The session will also discuss coupling algorithms, their robustness, as well as how they can be adapted for high performance computing.
- Field examples of the need for these complex, multi-physics models in large scale reservoir simulations will also be discussed.

Session 3: Multiscale Modelling Session Chairs: Ruben Juanes, MIT; Carol Woodward, Lawrence Livermore National Laboratory

Hydrocarbon recovery processes act at many scales in a reservoir including the pore/capillary scale (for single-, dual-, or triple-porosity systems), the geologic laminae scale, the core scale, the geologic bed scale, the imposed numerical grid scale, and the reservoir scale. The storage and transport mechanisms associated with

SESSIONS CONTINUED...

these hydrocarbon recovery processes may be dominated by different physical phenomena at each of these scales. The objective of this session is to discuss methods to model hydrocarbon systems at multiple scales. Topics to be considered include numerical multiscale techniques, characterisation of reservoirs at multiple scales for model input, unconventional (shale gas/oil) reservoirs, upscaling, and uncertainty analysis at multiple scales.

Session 4: Reservoir Management, Optimisation, Inverse Problems, and Uncertainty Quantifications Session Chairs: Hector Klie, ConocoPhillips; Gregory King, Chevron

This session will deal with the problem of estimating the distributions of porosity, permeability, and geological shapes (like reservoir boundary position) in heterogeneous and multiphase oil and gas reservoirs, by matching their dynamic behaviour. The dynamic data is in the form of field measurements from well testing, production history, interpreted 4-D seismic information. This process, called history matching by reservoir engineers, is an inverse or parameter estimation problem: inferring reservoir parameters from the indirect measurements. During the session we will discuss on parameterisation techniques, objective function, and inverse problem formulation for devising effective optimisation strategies. Strategies avoiding expansive gradient evaluations and solving adjoint problems will be in the scope of this session. Finding the optimal location of wells may increase significantly a field development project Net Present Value (NPV). This problem is nowadays one of the most challenging ones in oil and gas field development. Because of the very large number of wells involved in the production of giant reservoirs, global optimisation may be a precious help to select the best well patterns, well spacing in patterns, order of drilling different zones. The Session will also address global optimisation techniques and computational effort necessary for their implementation (in terms of number of reservoir simulations and associated computing time).

Model parameters being highly uncertain in the field of geosciences, managing uncertainties is also a major stake in the process of decision-making at every stage of reservoir production from field exploration to production. We will also discuss the development of statistical methods allowing for the evaluation of uncertainties impact and realisation of sensibility analysis on model parameters, with the aim of weighting uncertainties on reservoir production forecast.

Session 5: Large Scale Data Reduction/ Compression, Mining, and Visualisation Session Chairs: Klaus Stuben, Fraunhofer Institute; Knut Andreas Lie, SINTEF

Data generated by observation and numerical simulation are the key to understand, explore, and optimise oil and gas reservoirs. Results of many simulation runs are stored, archived, analysed, and compared among each other. This puts very demanding requirements on storage systems, networks, and visualisation systems. Approaches to overcome these issues are application specific data compression of single or multiple simulation results, data reduction methods, and sensitivity analysis. These technologies are enabler to support data mining of simulation results, for example, to find all simulation results with a similar behaviour of a reservoir. This session aims at presenting technologies for data compression of CFD applications as well as data reduction methods, which allow identifying major trends in sets of simulation results and allow for (non-linear) interpolation replacing computation with a new set of parameters. Human interaction with complex systems, e.g. for seismic interpretation or for reservoir modelling, relies on a good visualisation, helping users to explore and understand data, and also communicate that understanding to others. Visualisation is a central tool in carrying out analysis, enabling researchers, and other users to explore datasets to identify patterns, associations, trends, and more. A particular challenge again in terms of data volume and decision support is the analysis of several simulation results representing different loads or uncertain geologic formations. A good data visualisation of sets of results can help users to make robust decisions based on the data being presented. It should provide an effective representation of the underlying data, to help answer a particular question at hand. Communicating data in this way can support senior decision-makers engaged in strategic planning, service managers needing to understand where delivery could be improved, and managers wanting

to monitor performance. This session shall provide answers to related challenges in major areas: Information display and decision aiding, progress in human-system interaction, data reduction, and data compression.

φ

Ø

Session 6: Lessons in Large Scale Computing in E&P and Other Application Areas

Session Chairs: **Patrick Demichel**, Hewlett Packard; **Ulisses Mello**, IBM

As we progress towards Exascale computing at the end of the decade, we can observe that numerically intensive large-scale applications in several domains of science and business face numerous challenges to achieve three orders of magnitude performance improvement within 10 years. This will enable unprecedented application capabilities for a 21st century and will open up new frontiers of fundamental research spanning exploration and production, energy, life sciences, engineering, climate, environment, finance, and materials science. To achieve this ambitious goal, massive improvement in current state-of-the-art of power efficiency, scalability, and reliability of computing systems is required, along with exploitation of new technologies like non-volatily memory, silicon photonics, and threedimensional packaging. Lots of progress has been achieved, unfortunately Exascale will be radically different in many aspects to what we have learnt in the race to Petascale, in particular because we have reached the economical, power, complexity limits of all data centers/institutions. Some emerging problems could become rapidly critical inhibitors, like the data explosion. It is important to understand how new technologies will affect our architectures and how to adapt current and new emerging applications to obtain the greatest benefit of the potential at the lowest effort of transformation and minimise the pressure on the developers. For the designers it is very critical to understand how the code loads and data sets will evolve in the next generation of problems we expect to solve. Then a co-design effort hard/soft is a fundamental dimension of the success of the Exascale effort. In this session, we will discuss technologies and algorithmic transformations to make some fundamental breakthroughs that are necessary to reach the next frontiers.

REGISTRATION FOR



FLUID DYNAMICS AND SIMULATION OF GIANT OIL AND GAS RESERVOIRS

3–5 SEPTEMBER 2012 SWISSOTEL, ISTANBUL, TURKEY

First Name/Forename Middle Name SPE Member? TYes TNo Last/Family Name Member No._ Job Title Company/Organisation Street or P.O. Box Number _____ City _____ City _____ State/Province _____ Zip/Postal Code _____ Country _____ Country _____ ______ Facsimile ______ Telephone Email (required) Conference Fees: Conference Only USD 1,200 for SPE Members USD 1,400 for Nonmembers Conference and Accommodation USD 2,300 for SPE Members USD 2,500 for Nonmembers **Conference Fees for Academia: Conference Only** USD 600 for SPE Members USD 700 for Nonmembers Conference and Accommodation USD 1.700 for SPE Members USD 1.800 for Nonmembers Conference Only Fee includes: Technical sessions, materials, daily coffee breaks and luncheons, welcome reception (if applicable). Accommodation is NOT included in the conference only registration fee. Conference and Accommodation Fee includes: 3 nights single room accommodation (with breakfast), technical sessions, materials, daily coffee breaks and luncheons, welcome reception (if applicable). IMPORTANT: All SPE Middle East rates are net of taxes. The fees in this form do not include any local or withholding taxes. All such taxes will be added to the invoice. Do you wish to present a poster? (subject to selection) **Y**es **N**o Do you wish to be considered a Discussion Leader? (subject to selection) **Yes** No No If yes, please indicate which subject you would like to present on: Credit Card (Check One): American Express MasterCard Visa NO REFUNDS will be granted on cancellations on or after 3 August 2012. **Card Number** (will be billed through Society of Petroleum Engineers) Expiration Date (mm/yy) Security Code Name of Credit Card Holder (printed) Date _ Signature (required) Please inform us of mobility or special dietary needs ____ Payment by Bank Transfer: IMPORTANT-For reference: Please quote "12LSRS" and name of delegate Make Payment to: HSBC Bank Middle East Ltd, Jebel Ali Branch, P.O. Box 66, Dubai, UAE Account Name: SPE Middle East DMCC Account Number: 036-217131-100 Swift Code: BBMEAEAD **NOT AN SPE MEMBER?** IBAN: AE18020000036217131100 Join SPE when you register and save money by Cancellation and Refund Policy: paying the lower member registration fee! A processing fee of USD 100 will be charged for cancellations received before the registration deadline 3 August 2012 A portion of your dues is allocated • If you cancel after 3 August 2012, you will not be eligible for a refund

- No refund will be given if a registered delegate fails to attend the conference
- SPE must receive cancellation requests in writing by 3 August 2012, by fax on +971.4.457.3164, or by email to formsdubai@spe.org

Visa:

SPE Middle East, North Africa and India will assist in providing a visa invitation letter, upon request in writing, to confirmed registrants after receiving full payment of registration fees. Visa invitation letters take five days to issue from the date of request and it is the delegate's responsibility to obtain their own visa. SPE cannot issue the visa nor can we guarantee it will be obtained.

For questions or additional information contact: Michelle Boyd, senior manager-events at mboyd@spe.org.

to a JPT subscription and is not deductible or refundable.

To submit your registration online, please visit the event's website at: www.spe.org/events/lsrs. Alternatively, you can email this form to: formsdubai@spe.org, or fax it to: +971.4.457.3164.

SPE is what you need.

Worldwide events

SPE membership brings you discounted rates to more than 100 worldwide events where you can meet with other professionals to learn about and discuss the latest E&P technical advancements. Our conferences, workshops, and forums also provide opportunities for you to publish and present your latest ideas and findings.

SPE has something for everyone working in the upstream oil and gas industry, no matter where on the globe you may be.

Join our worldwide membership today at www.spe.org/join



Society of Petroleum Engineers