Training Course: GEOMECHANICS FOR UNCONVENTIONALS

Duration

2 Days

Learning goals

The ultimate goal of a geomechanics course is to enable course participants to build geomechanical models and apply these successfully to field development issues. Given this is only a 2-day course it should be seen as the first step to achieve this wider objective but we realistically expect course participants after attending the course to:

- Understand the workstep in building geomechanical models, and to be familiar in the theory behind these worksteps,
- Know what additional resources and standard textbooks can be used to build and apply geomechanical models,
- Have clarity in understanding in the assumptions in geomechanical projects, and be in a position to make a judgement on data requirements and input parameters. There will be ample discussion on assumptions made in different approaches to building geomechanical models,
- Read and understand geomechanical reports provided by service companies,
- Be able to challenge methods and assumptions in geomechanical reports with the report authors and have an informed discussion to improve the end result of a geomechanical project provided by a service company,
- Avoid the fate of becoming a person that unthinkingly clicks buttons in a software application to complete a workflow (“Nintendo-Geoscientists”). It is the aim of this course to impart understanding of Geomechanics that creates confidence in building and applying geomechanical models.

The main geomechanical applications in this course will on fractures and hydraulic stimulation (fracture orientation and containment, re-activation of pre-existing fractures versus creation of new fractures, shear fractures versus tensile fractures, fault stability), and wellbore stability. The course time will be split in equal parts between (i) underlying theory, (ii) building and calibrating 1D wellbore centric geomechanical models and (iii) building, calibrating and applying 3D and 4D geomechanical models. Special emphasis is placed on using 3D seismic inversions as a data source, specifically for unconventional wells the course will cover:

- Interdependence of elastic properties, pore pressure and stress state
- What governs horizontal stress
- Relationship of poro-elasticity and empirical PP-FG (Pore Pressure – Fracture Gradient) methods, or “the right equation for every occasion”
  - Fracture orientation
o Am I creating shear fractures or tensile fractures?
o First order controls on hydraulic fracture containment
o Hydraulic stimulation: creation of new fractures or re-activation of pre-existing fracture and weak bedding planes?

For further details and course dates please use the contact us form or contact us by email at pobrien@mpgeomechanics.com
Jorg has 20 years of experience in academic research and in the oilfield service industry. In his career in the petroleum industry he became a world leader in time-lapse seismic applications and 3D and 4D geomechanical simulations applied to Petroleum Exploration and Production. He has extensive experience in technology development, technology application, teaching and mentoring.

His recent work includes the lead in the development and deployment of a novel reservoir simulator which simultaneously solves the equations for fluid flow and geomechanics in one single simulation environment. Together with the team, Jorg deployed this new simulator to address geomechanical issues in field development planning, including well-bore stability in complex tectonic settings, seal-integrity, fault reactivation, inter-reservoir communication by crossflow and prediction of time-lapse seismic signals. Previously, Jorg discovered and implemented the concept of Seismic Geomechanics, a method to build and calibrate 3D and 4D geomechanical models using seismic data. This concept was conceptualized and implemented in a Research and Development Group, deployed the concepts as a consultant and lead the implementation as Petrel-based workflow, from model building to geomechanical applications. This work resulted in 4 patent applications, and an invitation by EAGE (European Association of Geoscientists and Engineers) to undertake a global lecture tour. In support of the lecture tour he wrote a text book on the subject of Seismic Geomechanics.

Jorg has always enjoyed sharing and distributing knowledge and best practice. For example, he has continuously mentored younger and less experienced colleagues both formally through a mentorship programme at Schlumberger and informally by building teams. Teaching experience includes giving classes for NExT, the Schlumberger training arm, and undertaking a global lecture tour for EAGE. Jorg has also examined several PhD theses at leading Universities in topics that are related to his research. Jorg is a member of SPE, EAGE, SEG, and PESGB. Since June 2016 Jorg has served as the Education Officer on the EAGE Board.
**Experience**

**Director**
**MP Geomechanics**
- SEG SEAM project: Model building and coupled reservoir and geomechanical simulations.
- Coupled reservoir and geomechanical simulations for Snøhvit CO2 sequestration.
- Reservoir simulations for high-pressure high temperature (HPHT) fields including 4D geomechanics.
- Projects for Oil Companies (confidential)

**Principal Geoscientist and VP Special Projects**
**Ikon Science, Teddington, UK**
- Initiate and carry out technology collaboration projects for 3D and 4D geomechanical simulations. Clients included Tullow Oil and Noble Energy.
- Supervise and guide the development of a finite-element geomechanics and reservoir simulator. Managing a team of 6 scientists and software engineers.
- Integrate results from quantitative seismic interpretation, pore pressure and wellbore centric geomechanical models into consistent shared Earth models.

**Principal Geophysicist, Applied Geomechanics Team**
**Schlumberger Information Solutions, Bracknell, UK**
- Technology advisor for exploration and production geomechanical models, maximising the use of seismic data. Clients included Wintershall, KOC, and Saudi Aramco.
- Create integrated workflows using Schlumberger’s software portfolio.
- Initiate and carry out collaboration projects with clients.

**Seismic Geomechanics Technology Champion,**
**Schlumberger, Data Consulting Services, Bracknell, UK**
- Technology advisor on global seismic geomechanics portfolio. Value of projects > 5 million USD/year.
- Business development for Seismic Geomechanics projects.

**Principal Geophysicist and Project Manager Seismic Geomechanics,**
**WesternGeco, Houston, USA and Gatwick, UK**
- 3D and 4D geomechanical model building using seismic data.
- Stress sensitive rock physics models during mechanical failure of rock.
- Integration of reservoir geomechanics, reservoir modelling results and time-lapse seismic.
- Analysis and interpretation of time-lapse seismic data.
- Managed a group of 3 scientists and engineers. Responsible for product definition, implementation and commercial roll-out.

**Senior Research Geophysicist**
**WesternGeco, Houston, USA**
- Geomechanical effects in 4D seismic data.
- Coupled fluid flow and geomechanical simulation.
- Stress-sensitive rock-physics models.
- 4D seismic attributes linked to pressure, stress and saturation changes.

**Research Geophysicist**
**WesternGeco, Gatwick, UK**
Development of integrated reservoir monitoring workflows and technology in
upstream Oil and Gas industry. Coupled reservoir flow and geomechanical modelling, Stress-induced shear-wave splitting in seismic data.

**Extended paternal leave, Belize, Central America**

**Research Associate**  
**Imperial College, London, UK**

Post-doctoral research on seismic signatures of fractures and development of anisotropic resistivity tomography method. First published inversion method for 3D inversion in heterogeneous, anisotropic media. Research on joint inversion of seismic and electric data.

**Research Assistant,  
Imperial College, London, UK**

Research in remote detection of fractures by geophysical tomography. Field experiments in crosswell electrical and seismic tomography. Development of 3D inversion algorithms for electrical tomography based on finite elements. Application of anisotropic seismic traveltime tomography. This employed position was carried out concurrently with my PhD studies.

**PhD, Department of Geology,  
Imperial College, London, UK**

Thesis advisor: Prof. Michael Worthington.

Scientific progress included the development and computer implementation of first anisotropic electrical tomography code, planning and carrying out of seismic and electric crosswell experiments, tomographic inversion of the resulting data and the interpretation of the tomograms.

**Diplom in Geophysics  
Technical University Clausthal, Germany.**  
Overall Grade: 1 (on a scale from 1-5, with one being best).

Studies included a five-year taught programme and a one-and-a-half-year research project. The programme provided a wide background in all aspects of geophysics, especially applied to mineral resource exploration and prospection. The course included a minor in petroleum geology.

**Exchange Student,  
Swiss Federal Institute of Technology (ETH) Zürich, Switzerland.**

Thesis advisors: Prof. Alan Green and Dr. Hansruedi Maurer
### Publications

#### Books


#### Journal publications


1. Yenugu, M., and Herwanger, J., Interdisciplinary integration made easier: Rock physics provides the link between geomechanics, geopressure and quantitative seismic interpretation, August 2014, Harts E&P


Patents and patent applications


1. Invited 1-day course on “Applications of 3D and 4D geomechanical models in petroleum exploration and production” for AAGGP (Asociación Argentina de Geólogos y Geofísicos Petroleros) and EAGE (European Association of Geoscientists and Engineers), 6th May 2016, Buenos Aires, Argentina


3. “Ask the expert session” on “Geomechanics” at 9th IPTC, 6-9 December 2015, Doha, Qatar

4. Invited panellist at SPE discussion forum on “Quo vadis: Geomechanics”, 27th October 2015, London, UK


6. Invited 1-day course at the 14th International Congress of the Brazilian Geophysical Society (SBGf) on “Applications of 3D and 4D geomechanical models in petroleum exploration and production”, 2nd August 2015, Rio de Janeiro, Brazil


9. 2011-2013 EAGE (European Association of Geoscientists and Engineers) Education Tour (EET-5) on “Seismic Geomechanics” (http://www.eage.org/index.php?evp=4792). EET-lectures are invited annually by EAGE on current geoscience topics and consist in a 1-day course presented by an acknowledged industry expert/academic and are presented in worldwide locations:
   - Adelaide, Australia,
   - Atyrau, Kazakhstan,
   - Beijing, China,
   - Buenos Aires, Argentina,
   - Calgary, Canada,
   - Canberra, Australia,
   - Caracas, Venezuela,
   - Cartagena, Colombia,
   - Copenhagen, Denmark,
   - Denver, U.S.A.,
   - Dhahran, Saudi Arabia (x2),
   - Hamburg, Germany,
   - Houston, U.S.A.,
   - Jakarta, Indonesia,
   - Kuala Lumpur, Malaysia,
   - London, UK (x2),
   - Perth, Australia,
   - Rio de Janeiro, Brazil,
   - Milan, Italy,
   - Moscow, Russia,
   - Muscat, Oman,
10. Schlumberger Reservoir Symposium for Europe. Two of my projects were awarded prices, with one project being awarded the price for innovation, and the other for business relevance.


12. Schlumberger Reservoir Symposium winner at the North America symposium. This price was one of the top four awards across all Schlumberger technology segments for projects carried out in North America.


16. Paper “R we there yet?”, judged as one of the best papers presented at the 70th EAGE Conference and Exhibition, 2008, Rome, Italy.

17. EAGE Distinguished Lecture Programme. Topic: “Linking geomechanics and seismics: Stress-effects on time-lapse seismic data”, delivered to
   a. Houston, U.S.A., 6. September 2007 (invitation by Marathon Oil),


19. Conrad Schlumberger Award for Innovation at the Schlumberger Reservoir Symposium, 9-11 December 2006. This price awards the most innovative new technology within SLB during the last year, judged by SLB fellow and is presented by the CEO.

20. Paper on “Linking geomechanics and seismics: Stress effects on time-lapse multicomponent seismic data”, judged as one of the best papers at the 67th EAGE Conference and Exhibition, 2005, Madrid, Spain. Resulted in an invitation to join EAGE’s Distinguished Lecturer Programme.
PhD theses examined

Thesis Title: “Seismic waveform simulation using hydro-mechanical reservoir models to assess time-lapse seismic attributes”
Candidate: Yanxiao He
Supervisor: Prof. Doug Angus
University: Leeds University
Year: 2015

Thesis Title: “Time-shift inversion for dynamic reservoir characterization”
Candidate: Alejandro Garcia
Supervisor: Prof. Colin MacBeth
University: Heriot Watt University
Year: 2011

Thesis Title: “Estimation of unsaturated flow parameters by inverse modelling and GPR tomography”
Candidate: Mohammad Bagher Farmani
Supervisor: Nils-Otto Kitterod and Henk Keers
University: Oslo University
Year: 2007