Short Course Catalogue 2019

www.LearningGeoscience.org
MAIN SECTIONS (DISCIPLINES):

Geophysics
• Seismic Acquisition
• Seismic Processing
• Surface Imaging
• Integrated Geophysics
• Seismic Reservoir Characterization
• Mineral Exploration

Geology
• Structural Geology
• Carbonate Geology
• Stratigraphy
• Geological Modelling

Reservoir Characterization
• Rock Physics
• Geomechanics
• Geochemistry

Near Surface
• Environmental Geophysics
• Non-Seismic Methods

Engineering
• Petroleum Engineering
• Reservoir Management
• IOR/EOR

Data Science
• Machine Learning

Training and Development
• Human Resources
• Soft Skills

ICONS

New
New course added to the catalogue 2019

In-House
This course can be requested for in-house training (subject to instructor’s availability)

Book
This course has a dedicated book available at the EAGE Bookshop

E-Lecture
This course comes with an EAGE E-Lecture that you can watch on YouTube
Welcome Words

The European Association of Geoscientists and Engineers (EAGE) recognizes the necessity for high-quality training and education throughout the lifetime of the industry professional. Indeed, we see educational tools as a key deliverable to our membership, especially relevant in our rapidly changing industry, and develop these accordingly. To this end, I would like to introduce the EAGE Short Course Catalogue in which you will find an overview of more than 90 short courses from a range of experienced instructors from industry and academia. We have carefully selected these courses to be multidisciplinary, in keeping with our association’s ethos, and to keep abreast of the latest trends in geoscience and engineering. Many of our courses are designed to be easily digested in bites of one to two days, sometimes longer depending on the topic, and are delivered by specialists who blend classroom theory and practical application. The EAGE organizes its courses in different formats worldwide:

- EAGE Education Days
- EAGE Education Tours
- Public short courses
- In-house courses

We also include abbreviated versions of our educational material as E-Lectures on YouTube. I strongly encourage you to participate in our short courses, which I am sure that you will find both high quality and professional in nature.

Finally, I should add that the EAGE is continually refreshing the catalogue to ensure it keeps pace with, and is relevant to, current industry developments. Should you have any suggestions or proposals for new courses please let me know.

I wish you an enjoyable and informative learning experience!

Colin MacBeth  |  Education Officer (EAGE Board)
EAGE is a professional association for geoscientists and engineers. Founded in 1951, it is a non-profit organization with a worldwide membership of 19,000 providing a global network of commercial and academic professionals. The association is truly multi-disciplinary and international in form and pursuits. EAGE believes that it is vitally important for all geoscientists to keep up-to-date on the latest developments in their field. For this reason the association actively develops and delivers education programmes for different audiences.

Learning Geoscience, the education portal of EAGE, is the focal point for a variety of education activities. EAGE organizes dozens of public and in-house short courses annually, including at the EAGE Annual Conference & Exhibition, other conferences and workshops, as part of EAGE Education Days and EAGE Education Tours (EET) and as standalone courses in several locations around the world. All short courses are revised regularly to make sure that they stay up-to-date and include the latest technologies in their respective fields.
EAGE Education Days

EAGE Education Days are multiple-course education events organized at various locations worldwide and delivered by distinguished geoscientists and professionals. Being flagship EAGE education events in each region, the Education Days short-course programmes are carefully selected by an expert committee to cover the learning demand in the region and to ensure a consistent programme with appeal to multidisciplinary Geoscience audiences.

Most Education Days are annually returning events. The short courses presented at Education Days are generally one to two days long and are open for registration to EAGE members and non-members, for whom membership is included in the registration fee. Most events offer a special fee for attending multiple courses.

EAGE Education Tours (EET)

Since 2006, the popular EAGE Education Tours (EET) have already attracted thousands of participants. An Education Tour on current Geoscience topics consists of a one-day course presented by an acknowledged industry expert/academic who visits various locations worldwide. The courses presented in this programme are specifically designed with an appeal to a wide audience, as opposed to some of the more specialized short courses in this catalogue.

By expanding the association’s geographic reach, these tours allow EAGE to fulfil its mission of providing members with access to the latest developments in Geoscience at an affordable price. All tours come with a dedicated course book, which can also be acquired separately from the EAGE Bookshop. Scheduled EET locations and available registration can also be found in the education calendar at www.LearningGeoscience.org.

Customized in-house training

Most of the short courses are also available as in-house training, which can be organized on a company’s premises and customized to better fit with specific needs. In-house courses are suited for groups of 10–20 participants, although sessions for larger audiences can be arranged as well. In-house courses can be complemented with a consultation session, if needed. Many instructors are flexible to customize the curriculum with individual preferences and training needs. If your company has a specific interest, do not hesitate to contact us for a personalized proposal.

An important benefit of the EAGE in-house format is the lower cost. It is often more cost-effective to have courses delivered at venues of your choice rather than sending a group of delegates to an external location. Engaging in training as a group and undertaking activities and discussions together can also serve as a team-building exercise, strengthen the bonds between colleagues, refresh team skills and boost confidence.

EurGeol Accreditation

Since 2013 EAGE has been an official Continuing Professional Development (CPD) Provider for the ‘European Geologist’ title, which is a globally recognized professional accreditation established by the European Federation of Geologists (EFG). In order to obtain and maintain this title, the holder must provide a record of high-quality CPD activities, which include short courses such as the ones presented in this catalogue. For more information about this accreditation system and corresponding EAGE learning activities please visit www.LearningGeoscience.org.

Find education opportunities for you

The courses presented in this catalogue are scheduled at various locations worldwide during the year. Visit EAGE Education portal www.LearningGeoscience.org and browse through different formats and a calendar of events designed for all professional development needs. If you are interested in a course but it is not delivered in your area, you can request it as in-house training. For personalized proposals and more information about programmed activities, contact us at education@eage.org.
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<td>Intermediate</td>
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Alphabetical list of short course instructors
Geophysics

Seismic Acquisition • Seismic Processing • Surface Imaging • Integrated Geophysics • Seismic Reservoir Characterization
Seismic Acquisition Project Essentials: from Concept to Completion and Beyond

Instructor: Mr Jan de Bruin (freelance Project Manager - Seismic Acquisition, Philippines)
Duration: 2 to 4 days
CPD Points: 10 to 20
Course level: Foundation

Course Description
Existing courses and books with the title ‘seismic acquisition’ typically deal with designing seismic surveys. Although this course treats design in a somewhat less conventional way, it is an important part of this course too, but other equally important subjects receive equal attention. These are: Clients, Finance, Procurement, Scouting, Communities, Execution, Equipment, HSE and Project Management. Any serious flaws in either of these can make a seismic survey less successful or fail altogether. Although these elements have nothing to do with geophysics, they are essential ingredients of seismic acquisition. The course will look at all this from the perspective of seismic companies as well as oil companies.

Course Objectives
The objective is to make seismic acquisition projects more successful. This is done by:

• Better understanding the goals of clients of seismic surveys;
• Better preparing for a seismic survey, through scouting;
• Making a better design of the survey (design is also covered in other courses);
• Learning how to improve relations with people living in the area of the seismic survey;
• Better managing the financial aspects of a seismic survey.

Participants’ Profile
This course suits professionals who want to understand why their last seismic survey was not as successful as they expected. This course will also be of interest if you are either a client of seismic survey, in procurement, providing finance support or in an HSE supporting or policing role related to seismic acquisition. Or for employees of seismic companies who want to have a better understanding of how seismic surveys are conceived, initiated and managed in oil companies. More detail about the exact reasons why oil companies want to acquire seismic data and how they go about this will also be a focus. Lastly, if you live in an area where a seismic survey will be conducted or if you are with an NGO in need of understanding more about seismic acquisition, then this course is for you.

Basic Geophysical Data Acquisition and Processing

Instructor: Dr Jaap C. Mondt (Breakaway, the Netherlands)
Duration: 5 days
CPD Points: 25
Course level: Foundation

Course Description
This course treats various geophysical methods, from gravity to magnetics, electrical, electro-magnetic, refraction and reflection seismic. It will be taught not only by explaining and discussing the methods, but above all by applying the theory in mainly Excel based assignments.

Various kinds of geophysical data are available. They are usually separated into Non-seismic and Seismic data. Non-seismic data (gravity, magnetics, electrical, electro-magnetics, spectral, etc.) is the main data used in shallow subsurface applications (engineering, mapping pollution, archaeology, etc.) and at the early exploration stage in the search for oil, gas or minerals. Seismic is the main subsurface evaluation tool for the EP industry, but it has its limitations. Therefore, non-seismic methods are used successfully as complementary tools at the more mature exploration stages and even for production. In combination with seismic data they can significantly reduce the uncertainty of subsurface models as they measure different physical properties of the subsurface. Controlled Source EM, for example, responds to reservoir resistivity and can thus be used to differentiate between hydrocarbons and brine in a geological structure mapped by seismic.

Course Objectives
At the end of the course, participants will have a good understanding of what information various geophysical data can give and for what purposes it can be used. This will enable them to specify the requirements for a survey or a reprocessing or interpretation project, either done in-house or by a specialised service provider.

Other benefits include:

• Place and value geophysical activities in a multi-disciplinary context;
• Judge the merits of various geophysical techniques;
• Better liaise and collaborate with staff in related disciplines;
• Recognise artefacts and direct hydrocarbon indications on seismic;
• Value novel developments such as time lapse methods for hydrocarbon reservoir monitoring or pollution control.

Participants’ Profile
The course is designed for geologists, geophysicists and petroleum engineers involved in exploration and development of oil and gas fields and for those involved in projects related to the shallow subsurface (monitoring pollution). In addition, it would be useful for those dealing with the effects of production of a field (subsidence, earth tremors).
Advanced Seismic Data Acquisition and Processing

Course Description
The course deals with advanced methods of seismic acquisition and processing. It will be taught not only by explaining the methods, but above all by applying the theory in mainly Excel based assignments.

Course Objectives
At the end of the course participants will have a good understanding of what information seismic data can give and for what purposes in Exploration and Production it can be used. This will enable them to specify the requirements for a survey, either done by themselves or by a special service provider.

Other benefits include:
• Place and value geophysical activities in a multi-disciplinary context;
• Judge the merits of various seismic geophysical techniques;
• Better liaise and collaborate with staff in related disciplines;
• Recognise artefacts and direct hydrocarbon indications on seismic;
• Value novel developments such as time lapse methods for hydrocarbon reservoir monitoring.

Participants’ Profile
The course is designed for geophysicists involved in designing and supervising seismic acquisition and processing, and for those involved in specifying/supervising the acquisition and processing done by service companies.

Advanced Marine Seismic Acquisition Techniques

Course Description
The course starts with an overview of conventional 3D towed streamer seismic acquisition and then concentrates on recent advances that have enabled dramatic improvements in seismic data quality and interpretability. While the development of 3D marine seismic acquisition since the 1980s has been arguably the single most effective technique in improved drilling success, the recent addition of ‘true 3D’ or ‘wide-azimuth’ techniques has led to improved sub-surface illumination and imaging. In addition to improved imaging, improved resolution has been achieved through so-called broadband techniques achieved through novel source and streamer geometries and multi-component receivers.

The course compares wide-azimuth towed streamer seismic acquisition as well as sea-bed seismic acquisition – ocean bottom cable (OBC) and ocean bottom node (OBN) – both from a design and practical implementation perspective as well as looking at relative cost-benefits. In the case of sea-bed seismic, the value of multi-component recording is reviewed. Broadband seismic techniques are explained in terms of source and receiver design, practical implementation and interpretational benefits. Time-lapse or 4D acquisition techniques are reviewed and discussed with an emphasis on repeatability of towed streamer, re-deployable OBC / OBN and permanent reservoir monitoring. Finally, the course reviews the latest developments in simultaneous source technology, which are attempting to improve dramatically the data density and / or operational efficiency of seismic acquisition.

Course Objectives
A practical approach is adopted and is designed to provide the student with an up-to-date understanding of recent developments in marine seismic acquisition technology. At the end of the course the student will be able to understand why and where these new technologies are applicable, understand what studies are required to design new surveys and understand the relative costs of acquiring and processing the seismic data compared to conventional acquisition.

Participants’ Profile
The course is designed for geophysicists and explorationists who wish to gain an overview of recent developments in 3D marine seismic acquisition. Participants are assumed to have a working knowledge of conventional seismic acquisition techniques and their use in exploration and development of hydrocarbon resources.
The Benefit of Broadband Technology for Reservoir Characterization and Imaging - the End-user Value

**Course Description**

The main aim of this course is to provide a very accessible overview of the many concepts behind broadband seismic (primarily offshore) and its implication for the reservoir focused asset based geoscientist. This will be done through the a very comprehensive set of case study material from all regions of the world and for various stages of the exploration, appraisal and development asset life cycle. The course aims to objectively discuss the various broadband seismic technologies and commercial offerings available today and their respective merits with regards to quantitative reservoir characterization and reservoir imaging using real world application examples. The course will further attempt to identify possible pitfalls and issues with regards to the treatment of broadband data that might lead to flawed or erroneous QI.

**Course Objectives**

Upon completion of the course, participants will be able to understand the value of broader bandwidth seismic data in general and for quantitative reservoir analysis from interpretation to rock property estimation in particular. The course is intended to be very applied and hands on and will only review the very basic concepts of inversion based rock property analysis and quantitative interpretation but will otherwise focus on examples to illustrate the benefit of extended bandwidth seismic.

**Participants’ Profile**

The course is designed for geoscientists with a basic level of geophysical knowledge, including a general knowledge of towed streamer acquisition and processing methods but the content is designed to be accessible for most geoscientists working with or interested in using broadband seismic in their day-to-day working life. In other words, definitely no requirement for expert knowledge.
**Time-lapse Seismic: A Multidisciplinary Tool for Effective Reservoir Management**

**Course Description**
Geophysical Reservoir Monitoring (GRM) of reservoirs relies on frequent time-lapse observations with high-survey repeatability. This technology is a key enabler for maximizing the oil recovery of oil and gas fields. The GRM technology aims at understanding and updating the knowledge of producing reservoirs. This is achieved through mapping the movement of fluid and pressure fronts and fluid contacts during production and injection. The combination of production monitoring with repeated seismic acquisition and geological and reservoir information provides reliable estimates of static and dynamic reservoir parameters.

The lecture will first review the geophysical reservoir monitoring history at Equinor (Statoil). We will share our experience with 4D processes, resources allocation and the overall monitoring strategy. The lecture will also cover challenges in understanding the 4D responses and value creation. Finally, we will look at how we push the GRM technology towards higher use of quantitative results.

**Course Objectives**
- Provide an overview of trends in 3D land seismic and achievements;
- Understand trade-offs in modern field technologies;
- Understand the ways to improve seismic imaging and data conditioning for better reservoir characterization.

**Participants’ Profile**
This course is beneficial to managers, geoscientists, reservoir and petroleum engineers with an interest in reservoir management and monitoring using time-lapse seismic.

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**Land Seismic on a New Technological Level**

**Course Description**
This course provides information related to recent trends and advances in land seismic data acquisition technology, equipment and the methodologies that are being utilized to improve seismic imaging quality and productivity of 3D acquisition with an emphasis on high-end surveys as performed in open areas. The course does not cover the fundamentals of 3D and multicomponent seismic survey design, although a section provides a review of recent survey design approaches and principles.

**Course Objectives**
The goals of this course are to:
- Provide an overview of trends in 3D land seismic and achievements;
- Understand trade-offs in modern field technologies;
- Understand the ways to improve seismic imaging and data conditioning for better reservoir characterization.

**Participants’ Profile**
The course is appropriate not only for geophysicists involved in land survey design, acquisition and modelling but also for those involved in data processing and interpretation who wish to better understand the potential improvements that can be made. The course assumes familiarity with basic seismic acquisition techniques and equipment. No mathematical background is required, since physical concepts are graphically illustrated. A comprehensive list of references is given in the book.
Land Integrated Survey Design

**Course Description**

This course presents an integrated approach to modern land 3D survey design as it has a key role in the seismic value chain going from acquisition to processing, imaging and inversion and characterization. It describes the main technology advances in land acquisition: high-channel count single sensor (point receiver), simultaneous source high-productivity vibroseis, broadband and wireless nodal systems. New acquisition technology has in turn inspired progress in processing, imaging and inversion and characterization. Survey designs have changed accordingly; wide azimuth high-density surveys are now the norm in many environments. And the survey design workflow now includes single sensor, single source, simultaneous source, broadband, symmetric sampling, cross-spreads, spatial continuity and more powerful 5D interpolation methods. It has also become more integrated, with requirements from inversion and characterization, imaging and processing feeding back to the design and hence acquisition.

**Course Objectives**

The purpose of this course is to understand:
- The main parameters related to land survey design;
- The generic land survey design workflow;
- The impact of the new acquisition technology on survey design;
- How design and acquisition affects processing, imaging and inversion and characterization.

**Participants’ profile**

Acquisition geophysicists who are naturally involved in survey design but also processing geophysicists and interpreters who wish to understand how acquisition programmes can be tailored to tackle their problems. The course may also be beneficial to geoscience (geophysics and geology) students. Participants are assumed to have a basic knowledge of seismic acquisition and processing techniques.

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Integrated Seismic Acquisition and Processing

**Course Description**

This course covers modern techniques in 3D seismic acquisition, introducing the seismic experiment as an integrated system composed of acquisition design, field operations, data processing, imaging and interpretation. This two-day course emphasizes how practical aspects of interpretation, data processing, imaging and/or field operations can either constrain, or liberate various survey design parameter choices. The concept of adjusting survey design parameters for optimum imaging of the subsurface target, while honouring equipment and/or field operations can either constrain, or liberate various survey design parameter choices. The concept of adjusting survey design parameters for optimum imaging of the subsurface target, while honouring equipment and/or field operations can either constrain, or liberate various survey design parameter choices. The course may also be beneficial to geoscience (geophysics and geology) students. Participants are assumed to have a basic knowledge of seismic acquisition and processing techniques.

**Course Objectives**

Each participant will gain a better understanding of the selection process for basic survey design parameters and how those parameter choices affect acquisition operations, data processing and the quality of the final image volume.

**Participants’ profile**

The course is designed for:
- Seismic acquisition specialists who wish to learn how to design cost-effective acquisition programmes that take advantage of modern state-of-the-art processing and imaging techniques;
- Seismic processing specialists who wish to learn some novel processing techniques to overcome perceived limitations in acquisition geometries;
- Seismic interpreters who wish to know more about both of the above.

Participants are assumed to possess a working knowledge of the seismic method and its use in exploration and reservoir management.
**Course Description**
This course serves as an introduction to the borehole seismic techniques being used by exploration geophysicists around the world. The fundamentals of acquisition, processing and interpretation are explored, and explained with case studies. The course also covers more advanced uses of borehole seismic, including 2D and 3D imaging, seismic model calibration, time lapse reservoir monitoring, and fracture detection. Basics concepts of survey planning, acquisition and processing are covered. Estimation of anisotropy, Q, and measuring AVO are also covered. Lastly, the course looks at the emerging Distributed Acoustic Sensing (DAS) technology. The course gives an introduction to crosswell seismic, and seismic while drilling.

**Course Objectives**
Upon completion of the course, participants will know the basics of acquiring and processing borehole seismic data. They will also be familiar with the latest borehole seismic techniques in:

- High resolution imaging using 2D and 3D VSP surveys;
- Anisotropy determination and fracture analysis;
- Reservoir monitoring using time lapse VSP and crosswell seismic;
- Alternative acquisition schemes such as SWD and DAS.

Participants will have a better understanding of the role of borehole seismic techniques in hydrocarbon exploration and production. They will be able to more knowledgeably participate in the design, planning and execution of advanced surveys and be comfortable with the interpretation of these surveys.

**Participants’ Profile**
The course is targeted toward those who have a basic understanding of surface seismic acquisition and processing, but only limited knowledge of borehole seismic. The course is designed to help participants identify borehole seismic solutions to common seismic interpretation problems. It is also be useful for those geophysicists needing higher resolution images than surface seismic can provide, and those geophysicists who need to validate seismic processing parameters and imaging models using borehole seismic. Lastly, the course is relevant for geophysicists wanting to learn how to use borehole seismic as a cost-effective reservoir monitoring tool.
**An Introduction to Velocity Model Building**

**Course Description**
The course will begin with a review of migration theory, emphasizing those aspects that affect our ability to build a velocity model of the subsurface and indicating when time migration should be replaced with depth migration (and what specific type of depth migration should be used). Ray theory and wave theory will be mentioned, in terms of how the scale length of a velocity anomaly versus the wavelength of the sound illuminating interacts. We will then cover the motivations for building detailed velocity models and briefly discuss the inherent limitations on our ability to build a detailed model. A review of anisotropy and of the principles of tomographic inversion will be given and current-day practice will be covered, exemplified via several case-studies. The approach will not be mathematical but rather will try to concentrate on an intuitive understanding of the principles and demonstrate them via case histories. This course will try to provide a complete overview but some topics such as VSP and multi-component data will not be covered.

**Course Objectives**
The course objective is to provide the participants a firm understanding of the processes and assumptions involved in building velocity-depth models and of the limitations of various migration algorithms.

**Participants’ Profile**
Geophysicists with an interest in migration and velocity model building and geologists (with a basic knowledge of data processing) who wish to understand a bit more about how the images they look at are created. Participants should have some knowledge of basic data processing.

**Instructor:** Dr Ian Jones (ION, London, United Kingdom)
**Duration:** 1 or 2 days
**CPD Points:** 5 or 10
**Course level:** Foundation

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**Applications of Seismic Anisotropy in the Oil and Gas Industry**

**Course Description**
Elastic anisotropy can strongly influence seismic data. This course discusses modelling, inversion and processing of seismic reflection and VSP data in the presence of anisotropy. The most critical step in extending the existing processing techniques to anisotropic media is to identify and estimate the medium parameters responsible for measured seismic signatures. The course emphasizes these parameters for vertical transverse isotropy – the anisotropic model usually associated with shales. Field-data examples illustrate the improvements in imaging achieved by anisotropic migration algorithms and the possibility of using anisotropy for lithology discrimination and fracture characterization.

**Course Objectives**
When the course is completed, students will have a clear understanding of the following:
- Seismic anisotropy is a real feature of the subsurface. It is caused by a number factors (e.g., lithology, fractures, fine layering) that can be quantified, leading to a better characterization of the subsurface;
- Any attempt of extracting more information from seismic data necessitates taking anisotropy into account;
- There exist established techniques for estimating anisotropy from seismic data.

**Participants’ Profile**
Geophysicists who wish to enhance their understanding of the subsurface and learn about modern techniques for extracting more information from seismic data.

**Instructor:** Dr Vladimir Grechka (Marathon Oil Corporation, Texas, United States of America)
**Duration:** 1 day
**CPD Points:** 5
**Course level:** Intermediate
Seismic Multiple Removal Techniques: Past, Present and Future

**Course Description**
The main objective of this course is to provide the audience with an overview of the techniques in seismic multiple removal, starting with the deconvolution-based methods from the 1960s, via the move-out discrimination techniques of the 1980s and ending up with wave-equation based methods from the 1990s and their 3D extensions as developed in the 2000s. Furthermore, the current challenges in multiple removal and their relation with seismic imaging and inversion are treated.

A secondary objective is to discuss more general processing concepts such as high-resolution seismic data transforms (Fourier, Radon), adaptive filtering techniques, wave-equation based forward and inverse wave propagation and the processing of seismic data in different transform domains. For each method some brief description of the theory in terms of mathematics is given. However, the emphasis in this course is not to thoroughly treat the mathematics but to present some understanding of the workings of each method.

**Participants’ Profile**
The target audience is composed of people involved in seismic processing, imaging and inversion. The mathematical content is kept to a minimum level with a strong link to the involved physical concepts, amplified by graphical illustrations. The audience is expected to have prior knowledge at a B.Sc./M.Sc. level on processing concepts such as convolution, correlation and Fourier transforms and some basic knowledge on wave theory. Participants should have a basic knowledge of:
- Basic signal processing (convolution, correlation, Fourier transform);
- Basic seismic processing (preprocessing, imaging);
- Basic knowledge on the acoustic wave equation and wave propagation.

**Instructor:** Dr Eric Verschuur (Delft University of Technology, the Netherlands)

**Duration:** 1 or 2 days

**CPD Points:** 5 or 10

**Course level:** Intermediate

Understanding Seismic Anisotropy in Exploration and Exploitation: Hands On

**Course Description**
This course covers all areas of applied seismic anisotropy, with class exercises and ample time for full discussion. Because anisotropy is such a fundamental concept, it covers topics in seismic acquisition, processing, imaging and interpretation, all based on seismic rock physics.

**Course Objectives**
This is not a ‘methods course’ but rather a ‘concept course’, familiarizing the students with essential concepts, enabling them to ask the right questions in future conversations, rather than to operate particular software packages.

**Participants’ Profile**
Geophysicists should attend who have a working knowledge of conventional exploration geophysics and wonder how it can be that we use isotropic concepts to acquire and analyze data that come from rocks that, after only brief thoughtful consideration, must clearly be anisotropic.

**Instructor:** Dr Leon Thomsen (Delta Geophysics, Houston, Texas, United States of America)

**Duration:** 2 days

**CPD Points:** 10

**Course level:** Advanced
Full-waveform Inversion: Where are the Anisotropic Parameters Hiding?

**Course Description**
The course starts by introducing the fundamentals of full-waveform inversion (FWI) starting from its basic definition. It focuses on the model update issues and provides analysis of its probable success in converging to a plausible model. In the course, we will discuss the many challenges we face in applying FWI on seismic data and introduce modern day proposed solutions to these challenges. The focus of the course will be on FWI applied to anisotropic media. Thus, the course will also introduce anisotropy, its optimal parametrization and wavefield simulation in such media. Practical multi-parameter inversion for anisotropic parameters requires an optimal FWI setup. We will discuss such a setup, which includes the proper parametrization of the medium and data access scheme necessary for a potential convergence to a plausible anisotropic model.

**Course Objectives**
Upon completion of the course, participants will be able to understand:
- The scientific foundation behind full-waveform inversion;
- FWI challenges;
- Wave propagation in anisotropic media;
- Anisotropy + migration velocity analysis;
- Anisotropy + FWI.

**Participants’ Profile**
The course is designed for geophysicists, mathematicians and physicists working on problems related to seismic imaging of the Earth and building the necessary velocity models to do so. Participants should have some knowledge on the physics of seismic wave propagation.

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Principles and Applications of Seismic Interferometry and Ambient Noise Seismology in Hydrocarbon Exploration

**Course Description**
This one-day course is designed for a broad range of seismic researchers, data processors and interpreters working in the petroleum industry. The course teaches the principles of seismic interferometry, ambient noise seismology and their applications to surface seismic, VSP and OBS data. The ultimate objectives are to enable geophysicists to evaluate the potential of seismic interferometry in uniquely solving their problems and to provide them with a basic working knowledge so they can explore the possibility of interferometric and ambient noise solutions. The instructor will select optional topics that are of most interest to participants. Both deterministic and ambient noise seismic interferometry will be presented.

**Course Objectives**
Upon completion of the course participants will be able to:
- Replicate the basic workflow for applying seismic interferometry to seismic data;
- Execute MATLAB codes for applying seismic interferometry to controlled source and ambient noise VSP and SSP data;
- Derive the basic equations of interferometry;
- Apply supervirtual interferometry to refraction data.

The diligent and well-prepared participant might be able to adapt a novel interferometric solution to their particular seismic problem.

**Participants’ Profile**
The integrated nature of this course means that it is suitable for seismic interpreters, researchers and data processors. Managers are encouraged to attend in order to consider the potential of seismic interferometry in solving some of their exploration and reservoir problems.
### Seismic Diffraction – Modelling, Imaging and Applications

**Instructor:** Prof. Evgeny Landa (Tel Aviv University, Israel)  
Dr Tijmen Jan Moser (Moser Geophysical Services, the Netherlands)

**Duration:** 2 days  
**CPD Points:** 10  
**Course level:** Foundation

#### Course Description

Diffraction phenomena have been identified as the key seismic manifestation of fractures and other small-scale reservoir heterogeneities. This two-day course will present the current state-of-the-art of diffraction technology and put this in context by a review of its past developments. The course will cover both forward diffraction modeling and diffraction imaging. Case studies of diffraction imaging will be presented covering applications in seismic exploration and other areas of geoscientific interest.

#### Course Objectives

The course will be clearly structured in topics and subtopics. At the end of each topic, a number of bullet points will summarize the items meant to be memorized and taken home by the learner. Interaction between the teacher and learner will be encouraged. The course material will be enlightenment by out-of-the-box examples demonstrating diffraction phenomena that support the techniques.

By the end of this course, the learner will:
- Have a detailed and up-to-date understanding of the physics of diffraction, diffraction modeling and imaging;
- Be able to effectively communicate the key aspects of diffraction technology with other professionals;
- Have a good understanding of the added value that seismic diffraction brings to current exploration and production projects.

#### Participants’ Profile

The target audience of the course consists in geoscientists from industry and academia with a basic knowledge of seismic processing and an interest in innovative interpretation technologies.
Beyond Conventional Seismic Imaging

**Course Description**
While depth imaging plays an increasing role in seismic exploration, data analysis and imaging in time domain play an important role. Moreover, for complex models that request the use of prestack depth migration, time imaging usually constitutes a key first step. The proposed course discusses: a) data analysis and imaging based on new procedures such as Multifocusing and Common Reflection Surface; b) diffraction imaging based on diffracted energy targeting to image small scale subsurface objects; c) imaging without precise knowledge of the subsurface velocity model (path summation); d) pitfalls and challenges of seismic inversion.

**Course Objectives**
Upon completion of the course, participants will be able to:

- Understand the role of time and depth imaging withing the general exploration work-flow;
- Understand the differences between several prestack data analysis approaches, in particular CMP, CRS and increase MF;
- Appreciate importance and potential of seismic diffraction for increase resolution and reliability of seismic imaging;
- Understand the uncertain nature of seismic velocity model and acquaintance to a way of taking the uncertainties into account;
- Understand and admit fundamental problems of seismic inversion including FWI.

**Participants’ Profile**
The course is designed for geophysicists working in data processing, imaging and inversion as well as for researchers and developers of new procedures for wavefield analysis and velocity model building.

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Seismic Depth Imaging and Anisotropic Velocity Model Building

**Course Description**
As the search for new resources forces to maximize the production of discovered reservoirs and explore new ones in domains that are increasingly complex, seismic imaging is becoming more and more important. This course will provide the audience with a unified overview of today's most popular seismic depth imaging techniques used in the oil and gas industry. These requires an estimate of how fast the seismic waves travel at any given point in the Earth and at any direction (anisotropy): the velocity model. Recent advances in seismic acquisition, imaging technology and high-performance computing allow us to correctly assess a much greater complexity of subsurface models and consequently, improve the accuracy of seismic images and detect structures that were previously invisible.

The course will present in simple terms (cartoons rather than equations!) the principle of different techniques in each class of methods (Kirchhoff, Beam Migrations, WEM, RTM), while pointing out their respective merits and limitations. Special emphasis will be on methods used to build the necessary anisotropic velocity models. Both ray-based techniques (linear and non-linear tomography) and wavefield extrapolation-based ones, including full-waveform inversion, will be addressed.

**Course Objectives**
Upon completion of the course, participants will be able to:

- Understand the potential value of the principal techniques used in seismic imaging;
- Understand differences between time- and depth-processing and select the best option for a given problem;
- Be aware of key steps and issues in building anisotropic depth velocity models with borehole control;
- Understand the complementarity between ray-based and wavefield extrapolation-based velocity model building;
- Be aware of current results and issues in full-waveform inversion;
- Evaluate the impact of recent breakthroughs in data acquisition on seismic imaging.

**Participants’ Profile**
The course can be understood by geoscientists with a moderate mathematical background. Physical concepts are presented without equations but with a maximum of simple schemes and animated graphic illustrations. However, some basic knowledge of wave propagation theory may help.
**Full-waveform Inversion for High-resolution Reservoir Characterization**

**Course Description**

The purpose of this course is to teach participants the fundamentals of extracting quantitative property information from seismic data. In the end this leads to an inversion process, which is called linear if the data are supposed to consist in primaries only and is non-linear if all multiple scattering and multiple mode conversion over a target interval (typically 500 m around the reservoir) is taken into account. Non-linear inversion leads to a higher resolution than obtained from conventional linear inversion techniques.

All steps required in these processes are based on wave equations and it is important, therefore, to have a good understanding of acoustic and elastic wave equations. In linear (AVO) inversion, first the reflection coefficients are derived from the data and subsequently the rock properties are derived from the reflection coefficients. In non-linear inversion, the properties are directly derived from the data. Non-linear inversion is an iterative process of which the first iteration (the Born approximation) represents the linear inversion result.

The method is based on an integral representation of the wave equation. An important aspect of reservoir oriented full-waveform inversion (FWI-res) is that the surface recorded data are localized (focused) to the target area. This can be achieved by redatuming or by local demigration of migrated data. Both the linear AVO data model in terms of reflection coefficients and the non-linear data model in terms of property contrasts against backgrounds are presented. Inversion, linear, or non-linear, requires regularization. Several regularization options are presented. Finally, linear and non-linear inversions at the reservoir scale are demonstrated by highly realistic synthetic reservoir models and real data case studies. The real data case studies include the extraction of low-frequency models (backgrounds) from well data and the extraction of angle dependent wavelets from the seismic-to-well match.

**Participants’ Profile**

This course is designed for geophysicists active in reservoirs and/or quantitative interpretation and processing geophysicists who would like to become involved in quantitative interpretation. Participants should have a basic training in geophysics and mathematics, particularly complex numbers and integrals.

**Migration, Velocity Model Building and Updating**

**Course Description**

The process of migration, whereby a proper image in time or depth of the subsurface is obtained, is directly related with the velocity model that both serves as input for the migration process as well as being the result of such a migration. Therefore, migration and velocity model building are intimately related processes. The implementation of migration is characterized by a multitude of methods and algorithms; there is also a great variety of methods to build a velocity model. This course provides an overview of the migration principles, methods and algorithms and an overview of velocity model building principles and methods and algorithms. Examples and case studies will conclude this course.

**Course Objectives**

At the end of the course the participants will have obtained a complete overview and thorough understanding of the many alternative methods and algorithms that are currently in use in imaging and velocity model building.

The course emphasizes for each method the underlying geophysical model together with its assumptions and strengths and weaknesses; many examples will be shown to illustrate the material; theory with references will be included; a handout that covers all course material will be made available.

**Participants’ Profile**

Geophysicists — processing and interpretation — geologists and petrophysicists who wish to understand how the various types of velocity information can be derived from seismic data and who wish to understand how subsurface images are generated. As the material covers the theory and practical implementations of present day practices, this course is relevant for those who are fresh from university as well as for those who wish to be updated on the newest developments. Participants should have a basic understanding of seismic acquisition and processing practices.
The Principles of Quantitative Acoustical Imaging

Instructor: Prof. Dr. Dries Gisolf (Delft Inversion, the Netherlands)
Duration: 2 days
CPD Points: 10
Course level: Advanced

Course Description
This course presents a systematic approach to imaging of acoustic reflection data and the extraction of media property information from the image amplitudes, based on wave theory. Although the approach is valid for a wide range of acoustical frequencies and applications, there is a bias towards seismic imaging. The theory of acoustic wave propagation is presented, from the constituent equations Hooke and Newton, to the acoustic wave equation, to wavefield extrapolation and eventually to extraction of image amplitudes.

This last process is treated as an inversion problem, where downward projected wavefields are directly inverted for the media properties. A feature of the course is the careful analysis of every step in these processes in terms of the linearity of the wavefields in the media property representation they are inverted for. During the course, live demonstrations will be given that show practical implementations of the theory presented.

Course Objectives
After attending the course, participants will have acquired a good understanding of the fundamental assumptions and limitations of state-of-the-art seismic migration. They will have been made familiar with the steps needed to extract quantitative property information from seismic data.

Participants’ Profile
Geophysicists from oil & gas (service) companies, or geophysicists from academia, involved in R&D. Participants should have a basic understanding of the seismic method as well as familiarity with mathematical tools like complex numbers and integrals.

Seismic Interpretation: Fundamental for Prospect Generation

Instructor: Mr. Dean Powell (Powell Seismic Services, Australia)
Duration: 2 days
CPD Points: 10
Course level: Foundation

Course Description
Clever software can pick seismic events but creative and informed interpreters are needed to produce prospects. This course moves beyond the mechanics of picking and helps participants understand and integrate the range of geophysical and geological considerations that lead to a rigorous seismic interpretation. From the basics of seismic acquisition and processing, through a review of seismic attributes, seismic stratigraphy and QI tools the course uses a mixture of theory, exercises, case histories and exploration experience to help participants gain confidence in using seismic data to generate prospects worth drilling.

Course Objectives
This is not a survey design course. Survey design is discussed but not covered in detail. After attending this course, the participant will:
• Recognize the limitations imposed on a seismic dataset by acquisition and processing specifications;
• Identify key mapping horizons and play types in a seismic dataset;
• Translate the seismic image into a realistic geological model;
• Generate credible hydrocarbon prospects.

Participants’ Profile
All those interested in seismic imagery. The acquisition geophysicist may discover an unfamiliar presentation of familiar concepts. The processing geophysicist may discover the causes of some types of perturbations in seismic images. Likewise, the interpreter may gain understanding of the limitations in seismic images. Those in charge of financing these images may understand better why they are so expensive.
**Geostatistics for Seismic Data Integration in Earth Models**

**Course Description**

In recent years the use of geostatistics has spread from the world of reservoir characterization to that of velocity analysis, seismic inversion, uncertainty quantification, and more generally to that of seismic data integration in earth models. Nevertheless, many geoscientists still regard geostatistics as little more than a statistical black box. By explaining the concepts and applications, this course clarifies the benefits of geostatistics and helps spread its use.

The course covers the use of geostatistics for interpolation (kriging, etc.), heterogeneity modelling (conditional simulation), uncertainty quantification, and data integration (cokriging, geostatistical inversion, etc.). A variety of applications and examples are presented, including velocity mapping, construction of realistic heterogeneity models, and seismic data integration in stochastic earth models. The relationships between geostatistics and approaches more familiar to geophysicists, such as filtering or Bayesian methods, are also discussed, without entering into mathematical details. A number of case studies are presented, covering examples from various parts of the world. The presentation provides an overview of basic concepts and applications. The course notes provide a support to the course and further extend some of the more technical considerations.

**Course Objectives**

As a result of attending this course, geoscientists will better understand how geostatistics fits into their workflow, what tools and techniques they should use depending on the problem at hand, and what added value may result from its use.

**Participants’ Profile**

Geoscientists (including geologists, earth modelers, petrophysicists, geophysicists and reservoir engineers) who have been exposed to applications of geostatistics but would like to improve their understanding.

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**Integrated Reservoir Modelling**

**Course Description**

This outcrop-based course provides participants with an overview of the integrated reservoir modelling process, tools and tasks. With a data set from a Tertiary carbonate reservoir, it exposes participants to hands-on integrated reservoir modelling. Conceptual reservoir and digital reservoir models are constructed on paper and digitally based on actual industry data. Common sedimentological techniques such as section logging, gamma ray measurements and interpretation of aspect ratios from photo panels and maps are demonstrated and practiced. QC of data versus interpretation is an integral part of the course and the uncertainty of all data sets is assessed. A strong emphasis is on stratigraphic correlation framework and structural model building. Property modelling and volumetrics are carried out interactively as a team exercise. Team interaction is a fundamental component of this course.

**Course Objectives**

As a result of attending this course, geoscientists will better understand how geostatistics fits into their workflow, what tools and techniques they should use depending on the problem at hand, and what added value may result from its use.

**Participants’ Profile**

Geoscientists (including geologists, earth modelers, petrophysicists, geophysicists and reservoir engineers) who have been exposed to applications of geostatistics but would like to improve their understanding.
Seismic Sequence Stratigraphy

Course Description
Seismic data offer more than structural information only; they can help define the chronostratigraphic framework of a sedimentary basin fill and provide valuable information on facies distributions within depositional sequences identified. Based on this it allows making reservoir predictions both in exploration and production working domains. The integrated approach permits detailed reconstruction of the basin fill history and therefore helps delineating flow units within a reservoir sequence. The range in observation scale makes the tool useful for basin analysis and reservoir modelling. The technique is essential for modern seismic reservoir characterization studies adopting a multi-disciplinary approach. Based on seismic examples and some ‘hands on’ interpretation exercises from different geological settings, attendees learn how to identify different depositional environments from seismic data, predict facies and gross lithological units (reservoir and seal pairs), estimate paleo water depths and evaluate subsidence trends and base level changes.

Course Objectives
The course objective is to discuss sequence stratigraphic principles and demonstrate their relevance to seismic interpretation. The basic workflow will be presented for seismic stratigraphic interpretation and basin evolution analysis, using case histories and field examples worldwide.

Participants’ Profile
Geologists and geophysicists involved in seismic interpretation for basin analysis / exploration / production and also for reservoir engineers who need more in-depth knowledge on the seismic expression of flow units and depositional environments. Participants should have a basic understanding of geology and depositional systems, as well as of the reflection seismic method.

Seismic Attributes and their Applications in Seismic Interpretation

Course Description
The course is divided into two parts: attributes review/applications and workflows. The first part starts with a review of seismic attributes and discusses the noise (random and coherent) reduction as one essential step of all attribute studies. The number of seismic attributes increased dramatically causing confusion for geoscientists to select appropriate ones. A series of trace-based attributes, volumetric dip and azimuth, fault detection and enhancement attributes, volumetric curvature and frequency decomposition are presented in this course and, for every attribute, a short theory will be followed by applications using examples from different sedimentary basins. Frequency decomposition is briefly presented with different decomposition methods such as wavelet transform, Fourier transform and matching pursuit analysis. Examples illustrate the interpretation challenges associated with frequency decomposition data interpretation.

The concept of multi-attributes and geobody extraction is introduced at the end of the first part of the course with examples on combinations of amplitude, phase, discontinuity and frequency attributes to visualize different geological objects. Iso-proportional slicing as a powerful interpretation tool is discussed. In the second part of the course stratigraphic and structural workflows will be presented using the acquired attributes. The workflows (and the elements for their planning) aim to show the integration of several attributes for specific interpretation purposes, with examples of stratigraphic (fluvial/shallow marine clastic systems, attribute expressions of deep water turbidites and carbonate settings) and structural imaging workflows. Lastly, the course analyses the importance of the integration of seismic attribute analysis processes with the other seismic interpretation (qualitative or quantitative) workflows.

Course Objectives
Upon completion, participants will be familiar with a range of relevant attributes used in seismic exploration and reservoir characterization. They will know the basics of how those attributes were calculated and will gain understanding of their applications in seismic interpretation. They will be able to plan some attribute workflows and they will know how to integrate attribute analysis with other disciplines of qualitative/quantitative seismic interpretation.

Participants’ Profile
The course addresses geoscientists involved in exploration and production projects where seismic play a role and who wish to learn the basic theory of the main seismic attributes used in exploration and production, as well as their applications and how to integrate them in exploration and reservoir characterization studies.
Seismic Fracture Characterization: Concepts and Practical Applications

**Instructor:** Dr Enru Liu (ExxonMobil, Texas, United States of America)

**Duration:** 1 day

**CPD Points:** 5

**Course level:** Foundation

**Course Description**
This course is an introduction to the fundamental concepts of seismic fracture characterization by introducing seismic anisotropy, equivalent-medium representation theories of fractured rock and methodologies for extracting fracture parameters from seismic data. With a focus on practical applications, three case studies are presented to demonstrate the applicability, workflow and limitations of this technology: a physical laboratory 3D experiment where fracture distributions are known, a Middle East fractured carbonate reservoir and a fractured tight gas reservoir.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Understand key geological aspects of fractures and their roles in hydrocarbon exploration and production;
- Understand the fundamental concept of seismic anisotropy and the equivalent medium representation of fractured rock;
- Understand the principal methodologies of seismic fracture characterization using shear-wave splitting and azimuthal variation of seismic attributes;
- Understand the basic data requirement, assumptions, limitations and applicability of seismic fracture prediction technology;
- Apply practical workflow introduced in this course to real seismic data;
- Interpret and integrate seismically-derived fractures with other measurements.

**Participants’ Profile**
The integrated nature of this subject means that the book and the associated course are purposely designed for individuals from all subsurface disciplines including geophysics, geomechanics, rock physics, petrophysics, geology, reservoir modeling and reservoir engineering.

3D Seismic Attributes for Prospect Identification and Reservoir Characterization

**Instructor:** Dr Kurt Marfurt (University of Oklahoma, United States of America)

**Duration:** 2 days

**CPD Points:** 10

**Course level:** Foundation

**Course Description**
Seismic data are incredibly rich in information, including amplitude, frequency and the configuration or morphology of reflection events. Seismic attributes, including volumetric estimates of coherence, dip/azimuth, curvature, amplitude texture and spectral decomposition, can greatly accelerate the interpretation of newly acquired 3D surveys as well as provide new insight into old 3D surveys. Successful use of seismic attributes requires both an understanding of seismic data quality and of sedimentary and tectonic processes. Participants in this two-day course will gain an understanding of the physical basis, geologic expression and petrophysical calibration of seismic attributes.

**Participants’ Profile**
- Seismic interpreters who wish to extract more information from their data;
- Seismic processors and imagers who wish to learn how their efforts impact subtle stratigraphic and fracture plays;
- Sedimentologists, stratigraphers and structural geologists who use large 3D seismic volumes to interpret their plays within a regional, basin-wide context;
- Reservoir engineers whose work is based on detailed 3D reservoir models and whose data are used to calibrate indirect measures of reservoir permeability;

Advanced knowledge of seismic theory is not required; this course focuses on understanding and practice.
Microseismic Monitoring in Oil and Gas Reservoirs

**Course Description**
The goal of this course is to explain principles of microseismic monitoring ranging from single monitoring borehole to surface and near surface networks. This course focuses on understanding the measurements made in passive seismic, their use and their uncertainties. Attendees should be able to decide on the best type of microseismic monitoring, design it, and know what kind of processing is needed to achieve their goals. They will also understand the uncertainties in the microseismicity. They will be able to avoid interpretation of uncertain observations. No requirement on prior class is needed, although knowledge of hydraulic fracturing and seismology helps. The course will also discuss the latest developments in microseismicity from source mechanisms, through tomography and anisotropy to reservoir simulations, including pore pressure analysis. The course discusses also social and scientific aspects of (induced) seismicity related to oil and gas reservoir.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Design an optimal array for passive seismic (surface or downhole) monitoring estimate uncertainties of locations for microseismic events;
- Orient downhole geophones from a perforation or calibration shot, estimate approximate distance and depth of a recorded microseismic event;
- Identify shear wave splitting in downhole microseismic datasets;
- Mitigate hazards associated with induced seismicity by fluid injection;
- Determine epicenter from the surface monitoring array and estimate source mechanisms of visible microseismic events;
- Determine if the seismicity in the vicinity of an oilfield is related to injection or extraction of fluids.

**Participants’ Profile**
The course is designed for users and practitioners in microseismic monitoring. No requirements prior to the course are needed, although knowledge of hydraulic fracturing and seismology would be beneficial.

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Seismic Reservoir Characterization

**Course Description**
Well and seismic data can be integrated to predict lithology and fluid, quantify reservoir properties, identify leads and help risk prospects. This course provides an introduction to the concepts and application of quantitative seismic interpretation including statistical rock physics analysis and modelling. This course discusses reservoir characterization as it applies to all stages of oil and gas field activity: from reconnaissance, through exploration and appraisal, to focused reservoir characterization during field development. As more data become available the options for QI increase. Workflows should be fit-for-purpose given project objectives and data availability. Reservoir characterization methodologies spanning qualitative attributes, inversion, probabilistic lithology and fluid predictions and the quantification of reservoir property distributions are presented.

These include well log calibrated amplitude and AVA interpretations, stack rotations and deterministic and stochastic inversion. The importance of petrophysics and rock physics calibration as a foundation for all of these methods is highlighted. The course also discusses seismic velocity modelling: the smooth merging of multiple 2D and or 3D velocity fields into a consistent 3D volume; and the calibration of seismic velocities to well data for accurate time-to-depth conversion. Depth conversion of seismic data and derived properties are important for facilitating well planning and field development decisions as well as for quantitative result interpretations.

**Course Objectives**
Upon completion of the course, participants will gain fundamental knowledge of the concepts, applications and benefits of multiple reservoir characterization techniques. They will be introduced to the importance of petrophysics and rock physics in establishing well-to-seismic calibration and in providing the framework for results interpretation. Participants will obtain an understanding of the data conditioning requirements for quantitative interpretation work and an appreciation of how to review results for quality and consistency.

**Participants’ Profile**
The course would benefit all technical staff in exploration and development who are interested in determining formation properties through seismic and log data integration.
Seismic Surveillance for Reservoir Delivery

Course Description
Time-lapse seismic surveys or 4D seismic provide snapshots of a producing hydrocarbon reservoir and its surroundings. The benefit of the technology in monitoring fluid and pressure changes and to point out bypassed oil or un-drained compartments has been well documented over the last 10–15 years. Still the technology is undergoing rapid development. One of the recent focuses has been the use of permanent seismic installation allowing for cost-effective frequent surveying, and an added benefit of providing additional recordings that would not be available without the permanent array. In addition, recent case studies have helped raise the awareness of how seismic monitoring techniques can be used to understand possible production induced effects outside the reservoir, often linked to geo-mechanical changes.

This course will provide some context on what is driving the dynamic changes linked to producing a hydrocarbon reservoir and what we should expect to observe using seismic technologies in a varied geological setting. It will address key issues that impact the feasibility of time-lapse seismic and evaluate established methods. However, the focus will be on ‘new’ technologies, use of a permanent array, frequent seismic surveying and integration of the data. Examples from the Valhall field will be used extensively to illustrate the potential of seismic data and to articulate issues related to interpretation and integration. This will include data examples from marine towed 4D, frequent surveying using permanently installed sensors, in-well recordings and analysis of passive data, including micro seismicity. Use of seismic surveillance information to support reservoir management, new well delivery and base management will be a central part of the presentation.

Participants’ Profile
This course is of interest to managers, geoscientists and reservoir and petroleum engineers who aim for integrating time-lapse seismic data into the next level of technical and business decisions and anyone else who sees the benefit of tracking changes in the subsurface in a wider sense. The intention is to inspire, educate and possibly entertain individuals on how to embark on a seismic surveillance project and stimulate new ideas for those with some experience in the topic.

The course will be biased towards marine seismic applications but this should not prohibit possible usage on land. Participants should have a basic appreciation of geosciences and petroleum technical principles linked to producing hydrocarbon.

AVO in an Inversion World

Course Description
AVO (Amplitude Versus Offset) analysis has been a key technology for de-risking drill targets as it can potentially distinguish different fluids and litho-types. Over time the application of the AVO technique has evolved and merged with seismic inversion methods so that today the traditional AVO analysis has been superseded by the analysis of rock property volumes on the interpreter’s work station. However, in order to derive these rock properties, we still rely on the fundamental principles of AVO. This course covers the basics of AVO theory and how it is used to create attributes or inversion volumes from seismic reflection data that reveal the rock and fluid characteristics of the subsurface. The course is not mathematical but does review some simple equations that help participants understand how AVO is applied to create quantitative measurements from surface seismic data and interpret those results in terms of rock physics.

Course Objectives
Upon completion of the course, participants will understand the commercial application of AVO and seismic inversion methods, know what the results tells in terms of rock physics and the possible limitations and errors in those results. Participants will be in a better position to critically analyze the results of such studies presented to them by contractors or partner companies. Participants will also be shown techniques to enable them to create some simple renaissance AVO data volumes using tools that are available in most interpretation packages.

Participants’ Profile
Interpreters, geologists, geophysicists and other specialists in geoscience disciplines who have an interest in understanding how AVO, rock physics and seismic inversion are applied in real world studies. Participants should have some knowledge of what seismic data is (prestack and post-stack) and what well log data is.
Geophysical Monitoring of CO₂ Storage

**Course Description**
The course discusses various methods for monitoring subsurface injection of CO₂. Specifically, the following topics will be covered:
- Rock physics related to injection of CO₂ into porous rock;
- Time-lapse seismic methods;
- Gravity and electromagnetic methods;
- Saturation and pressure effects;
- Early detection of leakage;
- Mapping overburden geology and identification of potential weakness zones;
- Field examples;
- Well integrity issues;
- Using gas leakage as a proxy to study potential leakage of CO₂;
- Laboratory experiments of CO₂ flooding including acoustic measurements.

**Course Objectives**
Upon completion of the course, participants will be able to understand possibilities and challenges related to geophysical monitoring of a CO₂ injection process.

**Participants’ Profile**
The course is designed for geoscientists working in oil companies, service companies and research organizations. Participants should have knowledge of basic geophysics and some geology.

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Rock Physics, Geomechanics and Hazard of Fluid-induced Seismicity

**Course Description**
Stimulations of rocks by fluid injections (e.g., hydraulic fracturing) belong to a standard reservoir-development practice. Productions of shale oil, - shale gas, - heavy oil, - geothermal energy require broad applications of this technology. The fact that fluid injection causes seismicity (including microseismicity and, sometimes, significant induced earthquakes) has been well-established for several decades. Waste water injection into rocks, large-scale water reservoir constructions and underground carbon sequestrations are other examples of potentially seismogenic fluid impact on geologic structures. Understanding and monitoring of fluid-induced seismicity is necessary for hydraulic characterization of reservoirs, for assessments of reservoir stimulation results and for controlling seismic risk of fluid injections and production. The course provides systematic quantitative rock-physical and geomechanical fundamentals of all these aspects of the fluid-induced seismicity.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Define the potential of microseismic monitoring for a particular task of the characterization of hydrocarbon and geothermal reservoirs;
- Use and discuss main instruments of the quantitative interpretation of microseismic data;
- Interpret main features of microseismic data;
- Discuss and control the quality of microseismic data;
- Interpret the mechanisms of microseismic events;
- Use and discuss following concepts: poroelasticity, reservoir properties, earthquake physical characteristics, microseismic event location principles, physics and modelling of hydraulic fracturing;
- Use and discuss main instruments for assessment of the hazard of induced seismicity.

**Participants’ Profile**
The course is targeted to geophysicists, geologists, petrophysicists, reservoir engineers, graduate and postgraduate students, researchers and interpreters.
Seismic Reservoir Characterization: An Earth Modelling Perspective

Instructor: Dr Philippe Doyen (Independent Consultant, London, United Kingdom)
Duration: 2 days
CPD Points: 10
Course level: Intermediate

Course Description
Three-dimensional numerical earth models play an increasingly important role in the petroleum industry to improve reservoir management and optimize hydrocarbon recovery. A key challenge for reservoir geoscientists is the quantitative integration of 3D and 4D seismic data into static and dynamic earth modelling workflows. Using a combination of theory and illustrations from real field studies, this two-day course reviews best practices and challenges for constraining earth models with seismic information and quantifying subsurface uncertainty.

Course Objectives
The course objectives of the course are to:
• Provide a practical introduction to techniques and workflows combining geostatistics and rock physics for the construction of seismic-constrained earth models;
• Explain how to integrate quantitatively seismic and well data in earth modelling workflows and evaluate the associated geo-model uncertainty;
• Describe the assumptions and technical limitations of current seismic-based geo-modelling techniques, thus helping reduce the black-box application of software tools;
• Highlight the technical challenges and the road ahead for quantitative seismic interpretation.

Participants’ Profile
The course is aimed at geoscientists and engineers who are involved in the construction of earth models and who wish to learn about practical techniques for seismic data integration, combined use of seismic rock physics and geostatistics, uncertainty modelling and quantitative 4D interpretation. The course comes at a time when seismic-based earth modelling has become a key activity for integrated asset teams in the E&P industry. It should therefore be of interest to a broad audience, including technical specialists and managers, who are actively involved or supervise seismic-to-simulator activities. Basic knowledge of seismic inversion techniques and geostatistics is desirable.

Geostatistical Reservoir Modeling and Uncertainty Quantification

Instructor: Dr Dario Grana (University of Wyoming, United States of America)
Duration: 1 day
CPD Points: 5
Course level: Intermediate

Course Description
Reservoir modeling provides a set of techniques to create three-dimensional numerical earth models in terms of elastic, petrophysical and dynamic properties of reservoir rocks. Mathematical/physical models of the reservoir are generally uncertain due to the lack of information, noise in data measurements, approximations and assumptions. The course focuses on geostatistical methods for reservoir modeling and uncertainty quantification techniques for reservoir predictions.

It is divided into four main parts: Geostatistical methods for interpolation and simulation; Rock physics modeling; Geophysical inverse problems; Uncertainty quantification.

Course Objectives
The course objectives of the course are to:
• Provide a practical introduction to techniques and workflows combining geostatistics and rock physics for the construction of seismic-constrained earth models;
• Explain how to integrate quantitatively seismic and well data in earth modelling workflows and evaluate the associated geo-model uncertainty;
• Describe the assumptions and technical limitations of current seismic-based geo-modelling techniques, thus helping reduce the black-box application of software tools;
• Highlight the technical challenges and the road ahead for quantitative seismic interpretation.

Participants’ Profile
The course is designed for employees of oil companies in geophysics and reservoir modeling.

**Course Description**

The purpose of this course is to familiarise mineral exploration geoscientists with the very latest developments in our understanding of the geophysical responses of mineral systems. The course revises the mineral system concept and considers these ideas in a geophysical context. New targets, in addition to traditional deposit-scale targets are proposed, e.g. fluid/metal source zones, fluid conduits and palaeo-reservoirs.

The geophysical responses of key mineral system components are considered from first principles. Physical property contrasts expected to be associated with different components are described and new methods of analysing petrophysical data are demonstrated. The use in mineral exploration of deep penetrating ‘academic’ geophysical methods is also described. Methods covered include the magnetotelluric method, deep seismic reflection profiling and teleseismic and ambient noise passive seismic methods.

Finally exploring for mineral systems using geophysical methods is demonstrated using examples from three important deposit styles: carbonate-hosted base metals, magmatic Ni-Cu deposits in mafic/ultramafic rocks and hydrothermal (orogenic) gold.

**Course Objectives**

On completion of the course participants will:

- Understand the mineral system concept and its implications for geophysical exploration, especially when exploring for blind targets;
- Know how to recognise responses from components of mineral system in their geophysical datasets;
- Be aware of recent developments in the use of deep-penetrating geophysical methods for mineral exploration;
- Understand how to use analyse petrophysical data to predict geophysical responses of mineral system components;
- Be familiar with the geophysical characteristics of common mineral system components, including the components of selected magmatic, sedimentary-basin-hosted and hydrothermal mineral systems.

**Participants’ Profile**

The course is designed for industry, government and student geoscientists who are using the mineral system concept to guide exploration and wish to understand how geophysical methods can be integrated in to their exploration strategy, and geoscientists with a basic understanding of geophysical data sets seeking to be innovative in their use of geophysical exploration methods.

Geological Interpretation of Geophysical Data for Mineral Exploration

**Course Description**

The purpose of this course is to provide training in how to use geophysical methods in mineral exploration. Designed for industry, government and student geologists seeking to understand how to use geophysical datasets to explore and map, and geophysicists seeking to include more geology in to their interpretations, this course teaches participants to integrate geological and geophysical data in a mineral exploration context.

Core topics include the basic principles of the main geophysical exploration methods used in mineral exploration including the importance of optimal processing and display of these data and the strengths and limitations of the various methods. Particular attention is paid to extracting the maximum amount of geological information from the data, recognising noise-related artifacts in interpretation products and how to deal with the ambiguity when interpreting geophysical datasets.

The course is based around a series of practical exploration exercises involving real exploration data. These data are processed and displayed, associated petrophysical data are analysed and then both quantitative (image analysis) and quantitative (modelling) interpretation methods are used to create an interpretation that combines all available geological and geophysical data.

**Course Objectives**

On completion of the course participants will:

- Understand how to integrate geological and geophysical information during mineral exploration;
- Have experience in interpreting a range of real geophysical datasets in a mineral exploration context;
- Have the ability to solve exploration challenges using geophysical methods;
- Be familiar with state-of-the-methods for analysing petrophysical data;
- Understand the capabilities and limitations of the various geophysical data types;
- Be aware of the importance of geophysics in the future of mineral exploration.

**Participants’ Profile**

The course is designed for industry, government and student geologists seeking to understand how to use geophysical datasets to explore for minerals, as well as for geophysicists seeking to improve the integration of geology in to their interpretations.
Geology

STRUCTURAL GEOLOGY •
CARBONATE GEOLOGY •
STRATIGRAPHY •
GEOLOGICAL MODELLING •
Geology for Non-geologists

Instructor:  Dr George Bertram (Stratigraphic Research Int., Glasgow, United Kingdom)
Duration:  2 days
CPD Points:  10
Course level:  Foundation

Course Description

The course comprises a series of talks on the fundamentals of geology interspersed with short practical exercises and discussions. The objective of the course is to introduce attendees to the science of geology with a particular emphasis on its application for the exploration of hydrocarbons.

Course Objectives

• Understand basic geological concepts, principles and terminology;
• Appreciate the role of geology in the hydrocarbon exploration industry.

Participants’ Profile

This course is principally intended for geophysicists who have no background in geology but it should be of value to all technologists working in the hydrocarbon industry who interact with geologists. Participants should have an understanding of basic scientific principles and an interest in finding out more about geology.

Tectonic-stratigraphic Evolution of the Central Tethys Realm since the Late Permian

Instructor:  Mr Eric Barrier (NCOC, Astana, Kazakhstan)
Duration:  1 day
CPD Points:  5
Course level:  Advanced

Course Description

This course describes the tectono-sedimentary and geodynamic evolution of the Tethys and Peri-Tethys domains, including the basics, platforms and orogenic belts that developed since the Late Paleozoic (post Hercynian evolution). The investigated region includes North-eastern Africa, Near East, the whole Middle East, Caucasus and Western Central Asia. In this course, the regional evolution is integrated into a geodynamic and kinematic context of the openings and closures of the oceanic Paleo- and then Neo-Tethys domains. One of the main objectives is to understand the tectonic and stratigraphic evolution of the continental Peri-Tethys basins and platforms.

A particular focus is cast on the relationships between tectonic and sedimentation in the basins that developed in these continental domains. While the geological history of the main basins and belts are described and discussed at length, the origin and evolution of the major sedimentary basins are more particularly described (timing, rifting, subsidence, inversion, sedimentology, environment, sedimentation). The relationships between the main kinematic changes and the major regional tectonic events are debated. This course integrates the most recent data from research projects and literature. It includes several case studies and paleo tectonic maps, reconstructions, figures, diagrams and pictures.

Participants’ Profile

Any geoscientist working, or interested in the geological evolution of the Peri-Tethys continental domains and more particularly in the NE Africa, Near east, Middle East and Central Asia geology. The course may more particularly concern petroleum geologists (junior and senior) working in basin analysis. Participants should have classical basic knowledge in geodynamics, kinematics, tectonics and sedimentology-stratigraphy.
Carbonate Reservoir Characterization

**Course Description**
This carbonate reservoir characterization course focuses on the analysis of carbonate depositional textures and the subsequent diagenetic modifications as the main controls on the pore system evolution, heterogeneity and complexity. The intricate inter-relationship of the depositional and burial history can be unravelled to allow the prediction of reservoir facies, and hence, aid reconstruction and development of three-dimensional reservoir models. This course demonstrates the value of understanding pore system evolution as a part of large-scale volumetric assessments and the development of carbonate reservoirs. The classification of individual pore types will be detailed in this course, with their primary depositional or secondary diagenetic origin being discussed in context with sedimentological and stratigraphic models in order to underpin their spatial relationships and potential connectivity. In addition, the characterization of micrite textures will be discussed to illustrate their impact on the microporosity, factors that are particularly important to consider in tight unconventional reservoirs.

Integrating the key controls on reservoir quality within the sedimentological framework enables the establishment of a conceptual reservoir architecture model, which can be used to assess and predict the vertical and lateral variations in porosity and permeability at the reservoir and/or field scale. This course outlines how to conceptually build a reservoir architecture model, which in turn can be used to aid reservoir modelling.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Identify the different pore types, their interconnectivity and hence the impact on permeability;
- Determine how specific sedimentological parameters and diagenetic process impact reservoir quality;
- Understand sample heterogeneity and its impact on reservoir quality data;
- Upscaling of reservoir quality data to aid prediction at the field scale.

**Participants’ Profile**
This course is designed for petroleum geologists, geoscientists, petrophysicists and engineers involved in exploration and production of carbonate plays.

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Sedimentological Characterization of Carbonate Rocks

**Course Description**
More than 60% of the world’s oil and 40% of the world’s gas reserves are held within carbonate rocks. An understanding of these will ultimately help improve sedimentological facies and reservoir quality prediction while reducing uncertainties with respect to reserve estimates and potential oil/gas recovery.

The first part of this course provides an understanding of the fundamentals of carbonate sedimentology, together with the skills required to characterize and interpret carbonate rocks, in order to establish an understanding of their depositional environment and implications for reservoir geometry and extents. In detail, the course offers an insight into the environmental, biological, physical, chemical and climatic controls on the carbonate factory, enabling facies analysis. In addition, sequence stratigraphical methods and their application will be covered in the second part of the course to provide all the tools needed to reconstruct the sedimentological architecture at the field scale. These factors help reduce uncertainties associated with the prediction of geometries and lateral heterogeneity within carbonate reservoirs.

**Course Objectives**
Upon completion of the course, participants will have:
- A good understanding of a carbonate system, including the major controls on carbonate production;
- An appreciation of the heterogeneous nature of carbonate sediments and how this may impact predictability variations within the subsurface;
- An understanding of the techniques used to apply a sequence stratigraphic framework in a typical carbonate succession, and hence the impact on reservoir quality prediction.

**Participants’ Profile**
This course is designed for petroleum geologists, geoscientists, petrophysicists and engineers involved in exploration and production of carbonate plays.
**Course Description**

An understanding of the depositional origin, together with the post-depositional modifications, is imperative to the successful exploration and production of carbonate sediments, which hold more than 60% of the world’s oil and 40% of the world’s gas reserves. Although carbonate rocks present complexity, this course is designed to understand the basic principles of carbonate sedimentology, diagenesis and reservoir characterization while making it straightforward to grasp and integrate the information.

The first part of this course is designed to develop skills in characterizing carbonate rocks and identifying and interpreting their depositional settings. The second session of the course will focus on the diagenetic processes and products that have an impact on carbonate reservoirs. The third and final part of the course will analyse the pore system evolution, integrating the intricate link between sedimentology and diagenesis to aid prediction of reservoir properties at the field scale.

This course will be accompanied by a series of in-class exercises, which will emphasize the integration of the various datasets, providing participants with experience in carbonate reservoir characterization.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Understand a carbonate system, including the major controls on carbonate production, describe carbonate sediments and their associated heterogeneity, and understand the techniques used to apply a sequence stratigraphic framework in a typical carbonate succession;
- Understand the various diagenetic processes that carbonate sediments are predisposed to and how to identify the origin of resultant products and hence their impact on reservoir quality. Knowledge on the analytical techniques used to characterize diagenetic products will also be gained;
- Determine how sedimentological parameters and diagenetic processes impact reservoir quality in order to aid prediction at the field scale.

**Participants’ Profile**

The course is targeted at all geoscientists, including petroleum geologists, petrophysicists and petroleum engineers involved in exploration and production of carbonate plays.
## Carbonate Essentials: Pores to Prospect

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Dr Christopher Liner (University of Arkansas, United States of America)</th>
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<td>Duration</td>
<td>1 day</td>
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<td>CPD Points</td>
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<td>Foundation</td>
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**Course Description**

This course is an overview of carbonates from geology to seismic interpretation, with a particular emphasis on karst topography and seismic expression thereof. Carbonate reservoirs represent over 60% of worldwide petroleum reserves, including emerging unconventional reservoirs. Unlike clastics, carbonate mineralogy is relatively simple, while complexity arises from depositional environment lateral variability, pore structure, diagenesis and dissolution. These factors influence bulk rock properties and, in turn, the seismic response. The course offers a broad overview of carbonate geology and properties that are mappable on a seismic scale as potential hydrocarbon reservoirs. To illustrate key concepts, field sites and case histories are presented from global locations.

**Course Objectives**

Upon completion of the course, participants will be able to understand:

- Carbonate geological classification, pore structures and the nature of karst terrain;
- Relationship of seismic parameters to carbonate rock properties;
- Use of full wave and dipole sonic to map fractures and classify in Vp/Vs-impedance space;
- Basic concepts of 3D seismic such as resolution and meaning of seismic amplitude;
- Carbonate horizon mapping with 3D seismic data in faulted and unfaulted terrain;
- Nature of carbonate lithology bright spots and geobody extraction;
- Parametrization and use of fundamental 3D seismic attributes in carbonate settings.

**Participants’ Profile**

The course is designed for seismic interpreters, geologists, reservoir engineers and technical managers. Early career geoscientists can benefit from the broad overview of this course, as well as seismic acquisition and processing geophysicists.

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## Top Seals and Fault Seals in Clastic and Carbonate Reservoirs: A Practical Approach

<table>
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<tr>
<th>Instructor</th>
<th>Dr Dirk Nieuwland (NewTec International, Leiden, the Netherlands)</th>
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<tr>
<td>Duration</td>
<td>2 days</td>
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<td>CPD Points</td>
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<td>Course level</td>
<td>Advanced</td>
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**Course Description**

The core of this course is a new powerful method of fault seal prediction and is intended for geologists, geophysicists and reservoir engineers in exploration. The course is based on geomechanics as a sound foundation for structural geological concepts and the behaviour of rocks in the brittle regime. Mechanical rock properties and ways and means to determine these properties form an important element of this course. Following an introduction to geomechanics, the theory of fracturing of brittle, ductile and viscous rocks is treated, illustrated with field examples and case histories. Different deformation mechanisms, based on mechanical rock properties, are treated in relation to realistic geological environments. Cataclasis is introduced as a major sealing mechanism, including a detailed account of the cataclasis process. Paleo-stress analysis is introduced, together with a new tool, the reactivation circle.

The course is very practical and focused on application. An exercise based on real data forms an important element of the course. Cases requiring the use of numerical models are discussed but numerical modelling is not part of the course.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Recognize the most appropriate fault seal mechanism for an area of choice and perform a quantitative fault seal analysis. If necessary, perform a paleo-stress analysis as a basis for fault seal prediction;
- Assess top and fault seal integrity for subsurface processes including exploration, field development and subsurface storage of natural gas or CO₂.

**Participants’ Profile**

The course is intended for geoscientists and subsurface engineers that deal with geological problems in relation to (potential) sealing problems with top seals and faults. This course will enable participants to assess top seal and fault seal potentials; in exploration cases with limited data availability but also in field development situations, with detailed data available, e.g. in relation to gas injection and top and fault seal issues.
Geological History of CO₂: Carbon Cycle and Natural Sequestration of CO₂

**Instructor:** Mr Alain-Yves Huc (UPMC, France)

**Duration:** 1 day

**CPD Points:** 5

**Course level:** Intermediate

**Course Description**

With respect to the current genuine public concern regarding the anthropogenic increase of greenhouse gases, a great deal of research and technology development focuses on the capture and underground storage of industrial quantities of CO₂. In addition, interest is attracted by the natural processes controlling the carbon cycle and the associated fate of atmospheric CO₂. The impact of the natural bio-geological processes affecting the CO₂ diluted in the atmosphere at a global scale, needs to be carefully considered in order to assess its role in the current and future state the atmosphere of our planet. As a complement to the study of the involved factors in the modern terrestrial eco-system, the geological perspective provides the opportunity to investigate these processes, their consequences and their kinetics at different time scales.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Place the current atmospheric CO₂ concentration in a geological perspective;
- Provide an overview of the methods used to approach the value of the past atmospheric CO₂ content;
- Review the change in the carbon cycle throughout geological time: evolution of source and sink.

**Participants’ Profile**

Anyone interested in the current atmospheric CO₂ concern and the evolution of the biogeochemistry of the Earth’s system.

Integrated Methods for Deep-water Reservoir Characterization

**Instructor:** Dr Jon R. Rotzien (Basin Dynamics, Houston, Texas, United States of America)

**Duration:** 2 days

**CPD Points:** 10

**Course level:** Intermediate

**Course Description**

Deep-water depositional systems form some of the largest petroleum reservoirs on Earth and represent the frontier of oil and gas exploration. However, deep-water depositional systems remain the least well understood because sediment gravity flows, including turbidity currents and hybrid and debris flows, are both infrequent and difficult to predict and monitor, setting them apart from sediment transport processes occurring on mountain tops and shallow marine settings. Therefore, modern seismic data and, in particular, deep-water outcrops provide prime sources of stratigraphic data used to risk drilling targets and build reservoir models at every phase in the upstream exploration and production process. This course focuses on sub-bed-scale and field-scale architectural elements in deep-water depositional systems and how they affect the main risks in deep-water E&P across the value chain: reservoir presence, deliverability, seal and trap.

The course has three main themes:

- Sediment gravity flows, sedimentation mechanics and resulting bed configuration;
- Depositional elements in the core, outcrop and seismic scale;
- Application and interpretation of risk and uncertainty from new ventures to field development and EOR.

**Participants’ Profile**

The course is designed for employees of natural resource companies in technical and management positions. Industry professionals will receive an understanding of deep-water sedimentary transport processes and depositional products, as well as knowledgeable insight into the scale and architecture of the wide range of deep-water reservoirs. This course draws from materials presented in Basin Dynamics, LLC field trips of major deep-water sedimentary outcrops worldwide. Participants should have knowledge of basic reservoir and exploration and development concepts, as well as experience with common geological, geophysical and engineering data.
More from Seismic – A Workshop on Seismic Stratigraphic Techniques

Instructor: Dr George Bertram (Stratigraphic Research Int., Glasgow, United Kingdom)
Duration: 2 days
CPD Points: 10
Course level: Intermediate

Course Description
Seismic data contain a wealth of information if you know where and how to look for them. Using a number of seismic based examples and ‘hands on’ interpretation exercises from different geological settings worldwide, attendees will learn how to identify different depositional environments, predict facies, (especially reservoir, source rock and seal) measure water depths, calculate subsidence trends, recognize and quantify sea-level changes and, where appropriate, determine the paleo weather conditions. Issues of flattening and datuming to improve the understanding of basin evolution will also be addressed.

Course Objectives
Upon completion of the course, participants will be able to:
• Understand the principles of seismic stratigraphy and apply them to the interpretation of seismic data;
• Use seismic data to decipher basin evolution;
• Apply techniques and ‘rules of thumb’ for lithological prediction using seismic facies variations, reflection geometries and geological models.

Participants’ Profile
Geoscientists, geologists and seismic interpreters, working in exploration or basin analysis, especially those interpreting seismic data with limited well control. Participants should have a basic understanding of geology and depositional processes, as well as the reflection seismic method.

Recognition of Sedimentary Environment from Primary Structures in Outcrop and Core

Instructor: Dr Janrik van den Berg (Utrecht University and ENRES International, the Netherlands)
Duration: 1 or 2 days
CPD Points: 5 or 10
Course level: Advanced

Course Description
The evaluation of reservoir properties such as geometry, porosity and permeability requires knowledge of the depositional environments that created the rocks, their spatial variability and temporal change. This course focuses on the analysis of physically formed sedimentary structures, such as cross-stratification. These are the ‘building stones’ of any depositional facies or depositional sequence. A proper and accurate interpretation of these ‘building stones’ in terms of bedforms and flow conditions is essential for understanding the origin and development of any depositional facies or depositional sequence. Knowledge of the physical background of the preserved structures is a prerequisite to understand the mutual relations of structures found in cores that guide us in interpretation solutions and that help us to keep our imagination of the paleo-environment within realistic borders.

Course Objectives
Upon completion of the course, participants will be able to:
• Understand the relationship between flow, waves, bedforms and primary sedimentary structures;
• Carry out process-related interpretation of primary sedimentary structures and common assemblages of sedimentary structures;
• Recognize diagnostic attributes for fluval, tidal, transitional fluvial-tidal and coastal depositional facies in outcrops and cores.

Participants’ Profile
The course is designed for geoscientists involved in core descriptions, core evaluations and borehole image interpretations. It is also recommended for those who use existing core descriptions for further evaluations, specifically sedimentologists, stratigraphers and reservoir geologists. Participants should have some familiarity with the basic principles of sedimentology.
Volumes and Risks Assessment for Conventional and Unconventional Plays and Prospects

**Instructor:** Dr Alexei Milkov (Colorado School of Mines, Colorado, United States)

**Duration:** 3 days

**CPD Points:** 15

**Course level:** Intermediate

**Course Description**

The course enables participants to transform qualitative geological descriptions of plays and prospects into technically robust quantitative success-case and risked volumetric models. Obtained learnings will help participants to evaluate probabilities of success (PoS) for exploration plays, segments, prospects, wells and portfolios and to assess the range of petroleum volumes in exploration projects. Examples and case studies come from both conventional and unconventional plays, prospects and wells around the world. The learning objectives are achieved through well-illustrated lectures, numerous hands-on exercises and active class discussions.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Use play-based exploration approach and tools (e.g., Common Risk Segment mapping, Field Size Distribution analysis, Creaming Curves etc.) to locate sweet spots in conventional and unconventional plays and assess remaining play/basin potential;
- Calculate deterministic potential (success-case) petroleum resources in conventional prospects and in unconventional plays. Assess and justify the range and probabilistic distribution of input parameters used in volumetric calculations;
- Assess geological risks and PoS for conventional and unconventional exploration, appraisal and development segments;
- Use industry-standard software (GeoX, REP or both) and run Monte-Carlo simulations to estimate unreisked and risked probabilistic volumes for plays, segments, prospects and wells;
- Recognize biases and logical fallacies common in exploration assessments and know how to correct them;
- Aggregate segments into a prospect and use risk and volumes dependencies between segments to estimate PoS and volumes for the prospect. Calculate PoS for wells;
- Aggregate prospects and wells into exploration portfolio. Predict the outcomes of portfolio drill-out;
- Evaluate drilling results to establish main reason(s) for well failure.

**Participants’ Profile**

The course is designed for geoscientists, engineers and managers who work on exploration projects and require competency in the assessment of risks and volumes.

New Tools and Approaches in Reservoir Quality Prediction

**Instructor:** Dr Dave L. Cantrell (Cantrell GeoLogic and Stanford University, USA)

**Duration:** 1 or 2 days

**CPD Points:** 5 to 10

**Course level:** Foundation

**Course Description**

Reservoir quality prediction has long been the ultimate goal of industry geologists, yet few have achieved this in a truly quantitative fashion. This workshop presents a new approach to reservoir quality prediction that involves the integration of a variety of modelling techniques to understand, quantify and predict the geological processes that control reservoir quality. Since initial reservoir quality is established at the time of deposition, numerical process models are used to predict initial reservoir quality; diagenetic process models are then used to modify these initial results and ultimately produce a quantitative and geologically-based prediction of present-day subsurface reservoir quality.

**Course Objectives**

Upon completion of the course, participants will be able to:

- The main controls on reservoir quality, for both clastics and carbonates;
- The main principals behind a geologically process-based approach to reservoir quality prediction;
- The quality and power of geologically based predictions, as well as some of the inherent limitations;
- How geological process models can be used to assess uncertainty in prediction results.

**Participants’ Profile**

The course is designed for geologists, reservoir engineers and technical managers - and for all others looking to enhance their understanding and ability to predict reservoir quality.
Non-linear Geostatistics for Reservoir Modelling

Instructor: Prof. Dr Stephen Tyson (Universiti Teknologi Brunei) and Dr Ing Sebastian Hörning (The University of Queensland, Australia)

Duration: 2 to 5 days
CPD Points: 10 to 25
Course level: Advanced

Course Description
The course will show the attendees how to test for linear spatial dependence and introduce the concepts of non-linear geostatistics. Attendees will develop an excel spreadsheet and a python notebook which can be used for spatial data analysis and non-linear stochastic simulation.

Existing geostatistics algorithms based on the kriging matrix can be shown to underestimate the connectivity of extreme values because they assume a linear spatial dependence model. Moreover, the estimation of uncertainty based on these techniques uses the kriging variance, which is not dependent on the values of the spatially distributed variable. It can also be shown that these uncertainty estimates are often implausible. This course will explain the reasons why most spatial variables in geoscience do not have a linear spatial dependence, even after monotonic transformations, and what the impact of this in the estimation of petrophysical properties. The course will show the attendees how to test for linear spatial dependence and introduce the concepts of non-linear geostatistics. Attendees will develop an Excel spreadsheet and a python notebook which can be used for spatial data analysis and non-linear stochastic simulation.

Course Objectives
Upon completion of the course participants will be able to:
• Assess whether spatial dataset has a linear spatial dependence;
• Determine the dependence structure between two or more variables (i.e. go way beyond linear correlation);
• Understand what different correlation measurements mean;
• Understand the importance of asymmetry in spatial modelling;
• Run spatial interpolation and simulation using copulas.

Participants’ Profile
This course is designed for petrophysicists, geomodellers, geologists, anyone with an interest in spatial modelling, volume estimation, preparation of simulation models and uncertainty analysis.

Basin and Petroleum Systems Modelling: Applications for Petroleum Exploration Risk and Resource Assessments

Instructor: Dr Bjorn Wygrala (Schlumberger, Aachen, Germany)

Duration: 2 days
CPD Points: 10
Course level: Intermediate

Course Description
The term ‘Petroleum Systems’ and the technology ‘Basin and Petroleum Systems Modeling’ will be introduced by showing applications in areas with critical exploration challenges, including salt basins and thrust belts. Technical breakthroughs in the last 10 –15 years have been the extension of the technology from 2D to 3D and the ability to perform multi-phase petroleum migration modeling using different methods in high-resolution geological models. This enables temperature, pressure and petroleum property predictions to be made with higher levels of accuracy and in the most complex geological environments such as in the sub-salt or in thrust belts.

Case studies will be used with live software presentations to illustrate key points. Applications of the technology will range from frontier exploration in which large areas with only sparse data are screened, to detailed assessments of exploration risks in structurally complex areas, to petroleum resource assessments of yet-to-find oil and gas.

Course Objectives
Upon completion of the course, participants will be able to understand modern petroleum systems modeling methods and their applications, as well as to be aware of their role and value in petroleum exploration and resource assessments.

Participants’ Profile
The course is accessible for geoscientists from all disciplines and for students with any level of experience. It is primarily directed at geologists but the data models and the quality of the results that can be achieved are dependent on geophysical and geochemical input, so all of these disciplines will benefit. The course will create awareness of a technology widely used in the industry that has rapidly developed in the last few years, which plays a critical role in exploration risk assessments, as well as in the assessment of yet-to-find hydrocarbon resources. Course attendees will learn that the topic is technically innovative and challenging and that the application of the technology offers interesting opportunities in the industry and in academia.
**Well Logs and Borehole Image**

**Course Description**
The most universal, comprehensive and concise descriptive documents on oil and gas wells are well logs. Familiarity with the applications of well logs is therefore essential for professionals forging their careers in the oil business. The course uses a core-based approach to help participants develop a good grounding in understanding and applying well logging techniques. General principles of physics are presented to explain the functioning of modern logging tools. Wherever possible, the physics of logging measurements is related to everyday tools and applications. Cross-plotting and reconnaissance techniques quickly and efficiently discriminate between water, oil and gas. Error minimization techniques, applicable only to computerized log analysis, produce optimal results. Participants benefit from realistic experience by working in teams on a comprehensive log interpretation exercise.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Understand geological application of the most commonly run well logs, i.e., caliper, gamma ray, sonic (velocity), resistivity, density, neutron, photoelectric factor, borehole images;
- Read log headers to understand which tool was run in which borehole environment;
- Quality control of the logs;
- Block logs in geologically meaningful intervals;
- Identify lithologies using various techniques such as common cross-plots;
- Calculate net-to-gross ratio and identify pay zones;
- Interpret the depositional environment.

**Participants’ Profile**
The course is designed for geologists, petrophysicists and stratigraphers. Basic understanding of geology and petrophysics is desirable, along with knowledge of the principles of geoscientific data management.

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**Best Practice in Pore Fluid Pressure and Fracture Pressure Prediction**

**Course Description**
All wells drilled require a pre-drill prediction of pore fluid and fracture pressures that defines the ‘drilling window’. This course explains the objectives, methods and uncertainties of prediction, based on extensive global experience. The necessary understanding of the geological/geophysical context of abnormal pressures leading to standard algorithms will be provided. Part of the challenge is terminology and contrasting display methods of geoscience and operations/drilling groups. Both approaches are necessary and investigated in interactive exercises, which will form an essential component of the course.

**Course Objectives**
Upon completion of the course the participants will be able:
- To know the elements involved in well planning that relate to pore fluid and fracture pressures;
- To understand the causes and how to recognize the occurrence of abnormal pressures in the subsurface;
- To know how to collect appropriate data to solve standard equations for pressure prediction;
- To comprehend the uncertainties in predictions from data selection as well as the variation in prediction methods and approaches;
- To understand how to communicate between geoscience and operations/drilling personnel in relation to pressure prediction.

**Participants’ Profile**
The course is designed for geoscientists (geophysics, petrophysics, geomechanics), engineers (operations, reservoir and drilling) and managers. Participants should have a working knowledge of oilfield operations, including the data types that are used in defining the geology of the subsurface as well as the components of drilling wells.
## Natural Fracture Systems and Fractured Hydrocarbon Accumulations, Mechanics and Management

### Course Description
This short course presents the fundamental geomechanics that is required to achieve a sound understanding of natural fracture systems, to predict the basic elements of natural fracture systems and to extract the wealth of information that is contained in natural fault and fracture systems, to the benefit of further development of naturally fractured systems.

The term ‘reservoirs’ has been deliberately avoided, because unconventional hydrocarbon accumulations such as found in tight reservoirs or shales, do not form ‘reservoirs’ in the classic meaning of the word. This is particularly so in shales, where the gas that is contained in the shales is adsorbed to clay minerals and cannot flow naturally. In such unconventional hydrocarbon systems, geomechanics is often the last and only resort to predicting attractive drilling locations, orientations and well stimulation such as hydraulic fracturing. A newly developed demonstration experiment will be used to illustrate the development of intersecting tension fracture systems.

### Course Objectives
- Assess the possibilities to approach the exploration and development of unconventional hydrocarbon systems. These can be shale gas systems, other forms of tight reservoirs or fractured crystalline basements.
- Participants’ Profile
Geologists, geophysicists and reservoir engineers who work with faulted and fractured reservoirs will benefit from this short course. The topic is relevant for exploration as well for production. A recent expansion of the course topics includes exploration and development of shale gas systems. Participants should have knowledge of general geology and structural geology and basic physics. A basic knowledge of geomechanics is an advantage but is not strictly required.

### Instructor
Dr Dirk Nieuwland (NewTec International, Leiden, the Netherlands)

### Duration
2 days

### CPD Points
10

### Course level
Intermediate

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## 3D Modelling of Naturally Fractured Reservoirs

### Course Description
Reservoir modelling for field development planning is a well-accepted process but its application to fractured reservoirs requires specific considerations which are less commonly known. This course briefly describes a practical methodology for building 3D static (‘geocellular’) reservoir models for naturally fractured reservoirs using standard modelling software, covering such considerations.

The issues addressed include the integration of log, core and seismic data, the process of defining and building the static reservoir model itself, and the creation of output in a form appropriate for dynamic modelling using dual porosity reservoir simulators where appropriate.

More complex workflows using discrete fracture networks will also be summarised, as will general issues of fracture description, uncertainty-handling and developing and managing fractured reservoirs.

### Course Objectives
Upon completion of the course, participants will be able to:
- Be aware of practical workflows for modelling naturally fractured reservoirs using standard industry software;
- Understand the data-gathering requirements and methodology for characterising fractured reservoirs;
- Appreciate the special distinction of naturally fractured reservoir models compared to standard single-porosity models.

### Participants’ Profile
The course is designed for Geoscientists newly working in naturally fractured reservoirs and petroleum engineers providing input to, or receiving output from fractured reservoir models.
Reservoir Model Design: How to Build Good Reservoir Models

**Course Description**
This short course will provide an introduction to reservoir model design, covering the following main design elements:
- Model purpose;
- The rock model;
- The property model;
- Model scaling;
- Handling uncertainty.

In this course, Mark Bentley and Philip Ringrose share their insights into building geological reservoir models, covering clastic and carbonate sedimentary depositional systems, as well as fractured reservoirs. The connection between geology and fluid flow is developed with a focus on designing fit-for-purpose models with the consideration of implications for single-phase and multiphase flow and with examples of application to oil and gas reservoirs and CO₂ storage. Integration of seismic data, well data and dynamic data with associated uncertainties are integral to the workflows and methods discussed. This is a shorter version of a 5-day course and so is intended as an introduction to the main concepts.

**Course Objectives**
Know how to approach a reservoir modelling task and assess the key design elements – distinguish between ‘good’ and ‘bad’.

**Participants’ Profile**
Geologists, geophysicists, petrophysicists, or reservoir engineers who have or wish to work in multi-disciplinary teams on reservoir development projects. Participants should have good knowledge of at least one component of multi-disciplinary reservoir modelling: e.g., geological modelling, geostatistics, petrophysics, rock physics, or reservoir simulation.

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Deepwater Sedimentary Systems: Exploration and Production

**Course Description**
Sandstones deposited in deep marine environments form important hydrocarbon reservoirs in many basins around the world. Interbedded mudstones can be important as source rocks, as well as acting as barriers, baffles and seals. Deepwater reservoirs are currently the principal target for oil and gas exploration, with over 1600 existing turbidite fields and plays. Driven by technological advances and much improved scientific understanding, the pace of exploration and discovery in this realm is fast accelerating. Keeping pace with these developments and with the new knowledge base is essential for all those involved in deepwater systems. What began as the turbidite reservoir has matured into the more varied deepwater play of the 21st century, including contourite and hybrid reservoirs. No company can afford to ignore these developments.

This course is designed to give the participant a state-of-the-art review and update, thereby providing an overall understanding of the complexity of the deep marine system. It will outline the processes and facies and how they evolve on the slope and in the open ocean; discuss how these facies build into distinctive architectural elements and how they can be recognized in the subsurface. The course also covers analysis and interpretation of seismic records, sea floor images, well logs (including borehole image logs), core materials, and outcrop characteristics of the component elements of deepwater reservoirs, emphasizing internal architecture as related to reservoir performance. Hands-on data packages from different deepwater plays around the world will be used to further illustrate their exploration, appraisal, development and reservoir management.

**Participants’ Profile**
All geologists, geophysicists and petroleum engineers involved in the exploration and development of deepwater plays. Project managers for deepwater plays and reservoir production.
Image Log Interpretation

**Course Description**

The course is designed for geoscientists, engineers and technical staff who wish to analyse and integrate image and dip data with other logs and seismic to enhance their understanding of exploration plays and field development. It leans heavily on worked class examples and case studies. Instead of interpreting image and dip data in isolation, the course shows how they can be used in conjunction with cores, other logs, modern depositional analogues, outcrop studies and hi-resolution seismic data to refine reservoir models. Tool principles, processing and quality control are discussed in the context of a deep-water case study with the IGNS in New Zealand. This is followed by a description of how images and dips can be used to interpret structural features and fault analysis.

Day one is concluded with case studies on fractured basement, carbonate and geothermal systems. On day two, image and dip applications in sedimentary systems are introduced with a discussion of Eolian settings and case studies from fluvial and deltaic settings where exploration plays are enhanced and seismic attributes calibrated to map reservoir hydraulic units. It continues with an analysis of the depositional controls on the petrophysics of siliciclastic and carbonate reservoirs in shelf and deepwater settings. The value of using image data to better evaluate thinly bedded reservoirs is also stressed.

**Course Objectives**

Upon completion of the course, participants will be able to understand how to quality control, process, interpret and integrate images and dips with petrophysical and seismic data to characterize reservoirs and improve exploration and field development strategies.

**Participants’ Profile**

The course is designed for geoscientists, petrophysicists and reservoir engineers working on subsurface data. Participants should have knowledge of geology and subsurface settings.
Reservoir Characterization

ROCK PHYSICS • GEOMECHANICS • GEOCHEMISTRY •
**Rock Physics for Quantitative Seismic Reservoir Characterization**

**Course Description**

The purpose of the course is to give an overview of rock physics observations and models relating reservoir properties such as saturation, lithology, clay content, and pore pressure and their seismic signatures. Understanding this relation can help to improve quantitative seismic interpretation. The course covers fundamentals of Rock Physics ranging from basic laboratory and theoretical results to practical “recipes” that can be immediately applied in the field. Application of quantitative tools for understanding and predicting the effects of lithology, pore fluid types and saturation, saturation scales, stress, pore pressure and temperature, and fractures on seismic velocity. Use of rock physics models requires understanding the assumptions and pitfalls of each model and the uncertainties associated with the interpretations using these models. Analysis of case studies and strategies for quantitative seismic interpretation using statistical rock physics work flows, and suggestions for more effectively employing seismic-to-rock properties transforms in Bayesian machine learning for reservoir characterization and monitoring, with emphasis on seismic interpretation and uncertainty quantification for lithology and subsurface fluid detection.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Use rock physics models with a better understanding of assumptions and pitfalls;
- Combine statistical rock physics in quantitative seismic interpretation workflows;
- Select appropriate rock physics models for reservoir characterization;
- Use rock physics models to build appropriate training sets for Bayesian machine learning applications in quantitative seismic interpretation.

**Participants’ Profile**

The course is recommended for all geophysicists, reservoir geologists, seismic interpreters, and engineers concerned with reservoir characterization, reservoir delineation, hydrocarbon detection, reservoir development and recovery monitoring.

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**3D Printing Geological Models For Education, Research, and Technical Communication — 3D Printing as an Emerging Technology in Geosciences**

**Course Description**

3D printing is an emerging tool in the geoscience research, reservoir characterization, education, and technical communication. This course covers fundamentals of available techniques and materials for 3D printing and their relative merits. Participants will learn about applications of 3D printing in studies of reservoir rocks, fossils, and geomorphology. The practical section of the course will allow participants: 1) to design 3D-printable models of reservoir rocks that contain pore and fracture networks using CAD and computed tomography data; 2) to render 3D terrain models using GIS data; and 3) to test the accuracy of digital and 3D-printed models.

**Course Objectives**

On completion of the course, participants will be able to:

- Understand capabilities and limitations of different 3D printing techniques;
- Demonstrate how to digitally design 3D-printable models using CAD software or computed tomography data;
- Provide the assessment of digital models and their relative 3D-printed replicas;
- Characterize how 3D printing can increase the effectiveness of communicating geoscience data;
- Apply 3D printing in current or future research and teaching.

**Participants’ Profile**

The course is designed in 2 days to accommodate a broad range of participant groups. Day 1 of the course covers an overview of 3D printing techniques and methods. It is useful for students, geoscientists and engineers who are interested in current advances of 3D printing in research and teaching. It can also be beneficial for managers and stakeholders who want to learn the use of 3D printing in technical communications. Day 2 covers research applications of 3D printing in porous media and geomorphology and involves practical section on creating 3D-printable models of reservoir rocks and terrains. It is beneficial for geologists, petrophysicists, stratigraphers, geophysicists, geomorphologists, reservoir and geomechanical engineers and geomodellers from both industry and academia. Participants will receive hand-on experience on creating digital rock and terrain models, validating their accuracy and exploring the best methods to 3D print them. In addition, day 2 of the course will involve review of current advances in research on 3D printing reservoir rock models.
**Applied Microfacies**

**Course Description**
This course discusses hands-on microfacies characterization using industry data sets including mineralogy, components, pore types and diagenesis. Participants learn how to capture observations such that patterns and rules can be detected. The course encourages participants to think of processes and products during thin section characterization. Industry data sets are used to illustrate the use of microfacies characterization to help solve operational issues of carbonate fields. Production increase is demanded. (Fully cored) wells show contrary production behavior. Thin sections are linked with petrophysical data, open hole logs and production data. Course participants are encouraged to use thin section descriptions to develop a conceptual model for permeability based on a depositional model architecture derived from the investigation of the sections.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Quality control thin sections;
- Determine the mineralogy of a stained section;
- Characterize fossiliferous and non-fossiliferous components such as ooids or brachiopods;
- Classify carbonate texture (Dunham) and grain geometry.

**Participants’ Profile**
The course is designed for geologists, petrophysicists, stratigraphers as well as explorers in academic and industry positions. Participants should have knowledge of the principles of carbonate geology and a fundamental understanding of petrophysics.

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**Digital Rock Technology**

**Course Description**
Digital rock technology is emerging as a potential predictive tool for the oil industry and promises to overcome limitations of conventional core flooding – in particular sensitivity to coring, core preservation, handling and preparation procedures. This course provides an in-depth description of digital rock analysis techniques with an emphasis on the fundamentals, tools and practical methods utilized in this workflow. Advanced methods and current limitations are also discussed. The course then highlights how this technology can aid the geoscientist and reservoir engineer today by complementing traditional measurements and using the results intelligently to predict and interpret field-scale recovery processes.

We describe examples where reconciliation and integration of the different types of data from a fundamental understanding of the pore scale has added value. In particular, the work is used to offer fast turnaround times, aided in our understanding of unconventional reservoir core material and to explain uncertainties and trends from laboratory measurements (e.g., issues with heterogeneity, representative elemental volume, wettability, distribution of remaining oil saturation, EOR processes). The course ends with a discussion on how to extend this technology for reliable prediction of petrophysical & SCAL data along continuous lengths of core material and to integrate the data with other forms of data at increasingly larger scales (log characterization, geomodels and ultimately reservoir simulators).

**Participants’ Profile**
The course addresses core analysts, petrophysicists, geoscientists, formation evaluation specialists and reservoir engineers. Basic core analysis knowledge would be beneficial.
Explorational Rock Physics and Seismic Reservoir Prediction

**Course Description**
This course covers fundamentals of rock physics, ranging from basic laboratory and theoretical results to practical recipes that can be immediately applied in the field, presenting qualitative and quantitative tools for understanding and predicting the effects of lithology, pore fluid types and saturation, stress and pore pressure, fractures and temperature on seismic velocity and attenuation. The importance and benefit of linking rock physics to geologic processes, including depositional and compactional trends as well as tectonic uplift and unloading, are key to this course, which demonstrates in detail how to build so-called rock physics templates that can be used to interpret both well log and seismic inversion data in terms of geological trends and reservoir properties. The course includes practical examples and case studies, as well as suggested workflows, where rock physics models are combined with well log and prestack seismic data, sedimentologic information, inputs from basin modelling and statistical techniques to predict reservoir geology and fluids from seismic amplitudes.

**Course Objectives**
Upon completion of the course participants will understand:

- The link between geologic processes and rock physics properties;
- Oore fluid / rock interactions during wave propagation;
- Upscaling and heterogeneous reservoirs;
- How to build their own rock physics template.

The ultimate goal is to improve the understanding of seismic amplitudes and predict geologic and reservoir parameters from seismic inversion data and at the same time create awareness about limitations and pitfalls.

**Participants’ Profile**
The course is intended for geophysicists, geologists and petrophysicists who wish to be involved in quantitative seismic interpretation. The course will focus on how rock physics can be used in exploration but many aspects will also be relevant for production and 4D geophysics.

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Rock Physics and Computational Geophysics

**Course Description**
This course presents the fundamentals of the physical principles and computational techniques for wave propagation in anisotropic, anelastic and porous media, including the analogy between acoustic waves (in the general sense) and electromagnetic (EM) waves. The emphasis is on geophysical applications for hydrocarbon exploration, but researchers in the fields of earthquake seismology, rock physics, and material science, -- including many branches of acoustics of fluids and solids (acoustics of materials, non-destructive testing, etc.) -- may also find the material useful. The course illustrates the use of seismic and EM modeling, with an account of the numerical algorithms for computing synthetic seismograms, diffusion fields and radargrams, with applications in the field of geophysical prospecting, seismology and rock physics, such as evaluation of methane hydrate content, upscaling techniques, detection of overpressure, Antarctic and permafrost exploration, exploration of the Earth’s deep crust, time-lapse for monitoring of CO₂ injection, seismic modeling in geothermal fields, seismic inversion, etc.

**Course Objectives**
On completion of the course, participants will be able to:

- Understand the physics of seismic (and EM) wave propagation and diffusion fields in real media, such as rocks and geological formations;
- Solve complex problems using numerical methods, as finite-differences, Fourier techniques, and machine learning methods;
- Apply these concepts to seismic and EM applications, such as hydrocarbon prospection, earthquakes, surface radar applications, EM low-frequency methods for environmental problems, rock physics, etc.

**Participants’ Profile**
The course is useful for geologists, geophysicists, petrophysicists and reservoir engineers. The emphasis is on geophysical applications for hydrocarbon exploration, but researchers in the fields of earthquake seismology, rock acoustics and material science – including many branches of acoustics of fluids and solids (acoustics of materials, nondestructive testing, etc.) – may also find this course useful.
Oilfield Geomechanics: Application to Drilling, Completions, Reservoir, Production, Geology and Geophysics

**Course Description**
The Baker Hughes Oilfield Geomechanics course covers the principles of in-situ stress and rock mechanics and their applications. We introduce applications in complex wellbores, in reservoirs that are faulted, fractured, depleted, or compacting, and in unconventional reservoirs. Concepts are reinforced and engagement is ensured with 18 class exercises and many more class discussion questions. The course is composed of five sections: 1) Introduction to Geomechanics; 2) Drilling; 3) Completions Engineering; 4) Geology and Geophysics; and 5) Reservoir Engineering.

**Course Objectives**
Course participants will:
- Calculate stresses, pressures, and rock properties;
- Calculate when faults will slip and determine the consequences of slip;
- Calculate stress concentrations around wellbores drilled in principal stress directions;
- Run a quick-look sand production prediction calculation;
- Gain a better understanding of their future reservoir challenges and how geomechanics affects their well planning and reservoir decisions.

**Participants’ Profile**
This is an intermediate course for anybody interested or involved in subsurface oilfield operations. Anyone impacted by rock failures, from beginning engineers to highly experienced supervisors and managers, can benefit from understanding geomechanics.

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Geophysics Under Stress: Geomechanical Applications of Seismic and Borehole Acoustic Waves

**Course Description**
The state of stress within the earth has a profound effect on the propagation of seismic and borehole acoustic waves, which leads to many important applications of elastic waves for solving problems in petroleum geomechanics. The purpose of this course is to provide an overview of the sensitivity of elastic waves in the earth to the in-situ stress, pore pressure and anisotropy of the rock fabric resulting from the depositional and stress history of the rock and to introduce some of the applications of this sensitivity. The course will provide the basis for applying geophysics and rock physics solutions to geomechanical challenges in exploration, drilling and production. A variety of applications and real data examples will be presented and particular emphasis will be placed on the rock physics basis underlying the use of geophysical data for solving geomechanical problems.

**Course Objectives**
Upon completion of the course, participants will:
- Calculate stresses, pressures, and rock properties;
- Calculate when faults will slip and determine the consequences of slip;
- Calculate stress concentrations around wellbores drilled in principal stress directions;
- Run a quick-look sand production prediction calculation;
- Gain a better understanding of their future reservoir challenges and how geomechanics affects their well planning and reservoir decisions.

**Participants’ Profile**
The integrated nature of this course means that it is suitable for individuals from all subsurface disciplines including geophysics, geomechanics, rock physics, petrophysics, geology, geomodelling and drilling and reservoir and petroleum engineering. The short-course presentation, limited to one-day, will provide an overview of the basic concepts and applications and minimizes the use of mathematical developments. As a result, the course presentation does not require a theoretical background and can be attended by a broad section of working geoscientists and engineers interested in applying geophysical data to the solution of geomechanical problems. The course book will provide support for the lecture and further extend some of the more technical considerations. Participants should have a basic knowledge of geology, geophysics and petrophysics.
Applied Oilfield Geomechanics

Instructor: Dr Jorg Herwanger (MP Geomechanics, Germany)
Duration: 2 days
CPD Points: 10
Course level: Foundation

Course Description

3D geomechanical models are frequently used to assess the state of stress inside the Earth. Knowledge of the stress-state in a reservoir and the surrounding rock allows assessing the risk of reservoir compaction, wellbore failure, sanding, breach of seal integrity and fault re-activation amongst others. Three-dimensional seismic data and inversion models can be used in building geomechanical models and time-lapse (4D) seismic data provide a means of calibrating the dynamic behaviour of reservoir geomechanical models. The purpose of this course is to provide an overview of currently available workflows to build and run calibrated 3D and 4D geomechanical models, maximizing the use of seismic data. By attending the course, participants will deepen their insight into each of the elements that comprise a 3D and 4D geomechanical model. Special attention is given to the way that seismic data assist in the process, what other data sources are required, how to calibrate geomechanical models and finally, how to interpret geomechanical models for a range of applications.

Course Objectives

The purpose of this course is to:
- Provide an overview of the currently available techniques of building and calibrating 3D and 4D geomechanical models;
- Demonstrate the interaction between rock properties, pore pressure and stress state;
- Apply the knowledge of stress state from geomechanical models to field development and reservoir management;
- Understand the limitations of current workflows and techniques and give a glimpse of the road ahead.

Participants’ Profile

Geomechanics projects integrate data and models from many different subsurface disciplines, including geophysics, rock mechanics testing, geology, geomodelling, rock physics and reservoir engineering. The course is designed for practising geoscientists and engineers and demonstrates how their discipline knowledge contributes to geomechanical modelling. The course is also beneficial to students of petroleum geoscience (geophysics & geology). Finally, the course also appeals to managers of subsurface teams, increasing the appreciation of the complexity of the subsurface workflows that his or her team needs to address.

Conduits and Seals in Hydrocarbon Reservoirs: A Geomechanical Approach

Instructor: Dr Dirk Nieuwland (NewTec International, Leiden, the Netherlands)
Duration: 2 days
CPD Points: 10
Course level: Intermediate

Course Description

Flow of oil and gas through porous reservoir rock is controlled by the permeability of the reservoir. In the simplest case this is a single permeability system that is completely controlled by the rock properties of the reservoir. The presence of faults and/or fractures complicates the flow by creating a dual porosity/permeability system when open fractures are present, or by creating barriers to flow or even reservoir compartmentalization when sealing faults or fractures are present. In this short course the origin of faults and fractures and their mechanical properties will be discussed in a framework of geo-mechanics.

Understanding the physical processes of fault and fracture formation enables the development of predictive models even in structurally complicated reservoirs. A combination of theory, case histories and exercises will be used to familiarize the participants of this short course with the subjects. The nature of a short course is such that a full in-depth treatment of the mechanics is not possible due to lack of time; the course emphasis will therefore be on informative case histories. Exercises will make up part of the course but in view of the available time, they will be relatively short.

Course Objectives

The participants will be able to decide on the appropriate fault sealing mechanism and perform a fault seal prediction. Location and orientation of natural open fracture systems can be predicted, using a variety of techniques. The methods taught in this course are universally applicable, including for exploration, field development and underground storage of natural gas or CO₂.

Participants’ Profile

Geologists, geophysicists and reservoir engineers who have to work with faulted and fractured reservoirs will benefit from this short course. The topic is relevant for exploration as well for production. Participants should have knowledge of basic geology, geophysics, reservoir engineering and structural geology. Also some practical experience in E&P projects is recommended.
**Geomechanics for Energy-related Applications**

**Course Description**
Geomechanics with multiphase and non-isothermal conditions are found in numerous energy-related engineering applications, such as petroleum engineering, nuclear waste storage engineering, unconventional energy resources and CO₂ geological sequestration. These applications require an understanding of the behaviour of the involved geomaterials (soils, rocks, shales) and an increased ability to predict their behaviours in variable situations. The course provides an insight on modern trends in geomechanics for dealing with geomaterials in multiphase and non-isothermal conditions. The course introduces the basic concepts for the characterization of the materials and their numerical modelling. The multiphase composition of the involved geomaterials and the concept of REV for a continuum mechanics approach are recalled.

Modern techniques for testing the materials under coupled (thermo-hydro-chemical-mechanical) conditions are introduced. The available evidences for the effects of the changes in the degree of saturation and temperature are summarized, providing the attendees with the possibility to anticipate the behaviours of geomaterials under non-isothermal and partially saturated conditions. Mathematical models are then presented to cope with these complex physical interactions in a quantitative manner and to be able to predict the behaviour of the materials in such conditions. Energy-related engineering applications are finally presented to show how the knowledge gathered with the course can be applied when dealing with complex natural and man-made systems.

**Course Objectives**
Upon completion of the course, participants will have a first-order understanding of the rheological behaviour of soils, shales and rocks under a variety of saturation conditions and temperature variations. Fundamental constitutive concepts will be well understood and a basic knowledge on the numerical simulation of geomechanical problems will be gained.

**Participants’ Profile**
The course is designed for postgraduate students, researchers and practitioners in fields where multiphase and non-isothermal behaviour of geomaterials (soils, rocks and shales) plays a fundamental role, such as petroleum engineering, unconventional energy resources, nuclear waste storage engineering and CO₂ geological sequestration. Participants should have basic knowledge of soil and/or rock mechanics is required.

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**Interpretation of Natural Gases**

**Course Description**
This course enables participants to add value in E&P projects through interpretation of natural gases. Examples and case studies come from both conventional and unconventional petroleum systems around the world. The instructor will transfer his practical knowledge of most important and relevant theories, interpretation tools and applications used in the industry. The learning objectives are achieved through well-illustrated lectures, numerous hands-on exercises, active class discussions and competitive games.

We will cover the following topics:
- Fundamentals of natural gas composition and properties
- Sampling of natural gas during drilling and production
- Analytical techniques used to determine molecular and isotopic composition of natural gases
- Interpretation of hydrocarbon gases (origin and processes)
- Interpretation and prediction of non-hydrocarbon gases (CO₂, N₂, H₂S, He and others)
- Using gas data and models to solve business problems in exploration, appraisal/development, production and environmental projects

**Course Objectives**
Upon completion of the course, participants will be able to:
- Design cost-effective fit-for-purpose sampling/analysis programs for natural gases
- Evaluate molecular and isotopic composition of hydrocarbon gases and interpret their origin (primary microbial, secondary microbial, thermogenic, abiotic) using state-of-the-art genetic diagrams
- Interpret the source, maturity, mixing and post-accumulation alterations of hydrocarbon gases
- Interpret the origin and sources of non-hydrocarbon gases (carbon dioxide, nitrogen, hydrogen sulfide, helium and others)
- Use gas data to solve business problems in exploration, appraisal/development, production and environmental projects
- Identify and propose geochemical solutions for E&P business problems

**Participants’ Profile**
The course is designed for geoscientists, engineers and managers who work on exploration, appraisal, development, production and environmental projects.
Petroleum Fluids and Source Rocks in E&P Projects

**Instructor:** Prof. Dr Alexei Milkov (Colorado School of Mines, Colorado, United States of America)

**Duration:** 3 days

**CPD Points:** 15

**Course level:** Foundation

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**Course Description**

The course enables participants to interpret fluids and source rock data to add value to E&P projects from exploration to environmental remediation. Examples and case studies come from both conventional and unconventional petroleum systems around the world. The learning objectives are achieved through well-illustrated lectures, numerous hands-on exercises and active class discussions.

We will cover the following topics:

- Fundamentals of petroleum composition and properties;
- Sampling of rocks and fluids;
- Analytical techniques used to evaluate potential of source rocks and composition of petroleum fluids;
- Characterization and risking of source rocks and prediction of fluid properties in exploration prospects;
- Interpretation of data from drilled exploration wells to assess the value of the discovery;
- Use of geochemical data to assess reservoir compartmentalization during appraisal and development;
- Geochemical surveillance of oil & gas production;
- Use of geochemical data to locate producing intervals and allocate petroleum production;
- Identification of oil sources for petroleum spills and leaks.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Identify and propose geochemical solutions for E&P business problems;
- Design cost-effective fit-for-purpose sampling/analysis programs for source rocks and petroleum fluids;
- Construct expulsion profiles for different types of source rocks;
- Predict fluid properties and product value in exploration and production wells;
- Correlate oils to source rocks;
- Interpret the origin of hydrocarbon and non-hydrocarbon natural gases;
- Integrate geochemical interpretations into holistic petroleum systems analysis;

**Participants’ Profile**

The course is designed for geoscientists, engineers and managers who work on exploration, appraisal, development, production and environmental projects and require competency in petroleum fluids and source rocks.
Near Surface

ENVIRONMENTAL GEOPHYSICS • NON-SEISMIC METHODS •
Near-surface Geoscience

Instructor: Dr Andreas Laake (Schlumberger, Texas, United States of America)
Duration: 1 day
CPD Points: 5
Course level: Intermediate

Course Description
This course covers the geological and geophysical concepts governing the near-surface. Methods for investigating and characterizing the near-surface such as remote sensing and surface geophysical methods are presented. The different measurements are archived and integrated in a geographical information system (GIS). The final integration reveals geological information about the near-surface and provides geophysical information for corrections in seismic data processing.

Course Objectives
The course introduces geomorphology as a concept to understand the geological and geophysical characteristics of the near-surface, enabling the students to extract structural and lithological information. This information can be used on one hand for the prediction of shallow drilling hazards and outlining deeper structures and on the other hand for the correction of near-surface effects in seismic data processing.

Participants’ Profile
Geophysicists and geologists who are working in exploration and are curious to understand the impact of the near-surface on subsurface geophysical data and who wish to understand what the surface geomorphology can tell them about subsurface structures. Participants should have a basic knowledge of geophysics and geology.

Gravity and Magnetic Methods for Oil & Gas and Mineral Exploration and Production

Instructor: Dr Yaoguo Li (Colorado School of Mines, United States of America)
Duration: 1 day
CPD Points: 5
Course level: Foundation

Course Description
Gravity and magnetic data are among the oldest geophysical data acquired for the purpose of resource exploration and exploitation. They currently also have the widest areal coverage on the Earth, span a great range of scales and play important roles in mineral, energy and groundwater arenas. The interpretation methods have evolved from data map-based visual inspection, various map enhancements and depth estimation, to quantitative interpretations based on inversions and integrated modelling. In particular, 3D inversion techniques have emerged as a major component in this evolution. The availability of 3D inversion techniques has advanced potential-field interpretation from ‘anomaly bump hunting’ to 3D imaging of the subsurface by reconstructing the distribution of density or magnetic properties in various geological units and, thereby, have shifted interpretations from the data domain to the model domain.

Similarly, inversion techniques are also poised to make major contributions to integrated modelling and interpretation, as well as to differentiating and characterizing geology, geological processes and reservoir dynamics. This course will focus on the methodology, numerical computation, solution strategy and applications of 3D physical property inversions of gravity and magnetic data sets. The course is designed to have two tracks in order to meet the different needs of the EAGE community in mineral exploration and in oil & gas exploration and production. We achieve this by dividing the course into two parts; methodologies common in potential-field methods in Part I and discussion of tools and applications specific to mineral exploration or oil & gas reservoir monitoring in Part II.

Participants’ Profile
Participants are expected to have a basic background in applied geophysics and some knowledge of potential-field methods. We anticipate geoscientists in the following areas will benefit from the course:
• Potential-field methods
• Mineral exploration
• Integrate interpretation
• Reservoir monitoring
• Groundwater hydrology
Overview of EM Methods with a Focus on the Multi-transient Electromagnetic (MTEM) Method

Instructor: Dr Bruce Hobbs (University of Edinburgh, United Kingdom)
Duration: 1 day
CPD Points: 5
Course level: Intermediate

Course Description
Reservoir rocks contain water, hydrocarbons or a mixture of both. The resistivity of those rocks is a sensitive indicator of hydrocarbon saturation levels and may be determined remotely by electromagnetic (EM) methods. The multi-transient electromagnetic method (MTEM) is a technology with sufficient resolving power to delineate potential reservoirs and to monitor hydrocarbon movements in a commercial context.

Course Objectives
The objective of this course is to provide an understanding and appreciation of the technology and its capabilities so that geoscientists will feel confident in incorporating the method into their appraisal and decision-making workflows. Another objective is to understand the contribution that MTEM technology can make to appraisals and workflow in exploration and monitoring.

Participants’ Profile
Geoscientists. Participants should have knowledge of basic science.

The Use of Surface Waves for Near-surface Velocity Model Building

Instructor: Dr Laura Valentina Socco (Politecnico di Torino, Italy)
Duration: 1 day
CPD Points: 5
Course level: Intermediate

Course Description
The use of surface wave analysis for near-surface characterization has dramatically increased in the last decade thanks to the possibility offered by this technique for shear wave velocity estimation. New tools and approaches have been developed for surface wave data acquisition and analysis to make the method robust and suitable to complex systems. The course will supply an overview of the method starting from surface wave propagation and dealing with acquisition, processing and inversion of surface wave data. Advantages and weaknesses of different approaches as well as requirements for data acquisition and analysis will be discussed. Recent developments will be presented with example of results and applications to different near-surface problems.

Course Objectives
The course will provide the participants with a wide overview of the main steps of the surface wave method: acquisition, processing and inversion. Different approaches with their potentialities and limitations will be discussed through many practical examples to enable the participants to acquire knowledge about the requirements and design of data acquisition, processing methods and inversion algorithms for different applications from small-scale engineering problems towards large-scale exploration.

Participants’ Profile
Near-surface geophysicists and exploration geophysicists interested in near-surface velocity models. Participants should have basic knowledge of sampling principles, spectral analysis and inversion of seismic data.
Exploring with Airborne Gravity Gradiometry

Course Description
The course combines a series of presentations on airborne gravity gradiometry (AGG) with hands-on exercises and class discussions. The objective of the course is to introduce attendees to AGG with a particular emphasis on its application to exploration for hydrocarbons and mineral resources.

Course Objectives
Upon completion of the course, participants will have a deeper understanding of:
- The differences and similarities between AGG and conventional gravity;
- The current AGG technologies (FTG and FALCON) as well as the emerging new AGG technologies that may become available in the near future;
- The sensitivity of the AGG technologies — what may and may not be detected — and how to design an AGG survey to deliver maximum value to their exploration programme;
- The ways to interpret AGG data and how to integrate the interpretation with seismic and other geophysical data;
- A number of case studies ranging from base metals to hydrocarbon exploration plays.

Participants’ Profile
The course is presented with a minimum use of mathematics and is intended for any exploration geophysicist/geologist interested in learning about airborne gravity gradiometry.

Satellite InSAR Data: Reservoir Monitoring from Space

Course Description
Satellite radar data for surface deformation monitoring are gaining increasing attention and not only within the oil and gas community. They provide a powerful tool for remotely measuring extremely small surface displacements over large areas and long periods of time, without requiring the installation of in-situ equipment. However, apart from remote sensing and radar specialists, only a relatively small number of geoscientists and engineers understand how a radar sensor orbiting the Earth at about 7 km/s from 700km above the Earth’s surface can actually measure ground displacements of a fraction of a centimetre. This course provides a step-by-step introduction to satellite radar sensors, SAR imagery, SAR interferometry and advanced InSAR techniques. Rather than a tutorial for remote sensing specialists, the course starts from very basic concepts and explains in plain language the most important ideas related to SAR data processing and why geoscientists and engineers should take a vested interest in this new information source.

Special attention is paid to oil and gas applications where surface deformation data can provide valuable constraints on reservoir dynamics, enabling time-lapse monitoring of volumetric strains at depth. After demonstrating case studies focusing on secondary and tertiary oil recovery, Carbon Capture and Sequestration (CCS) and Underground Gas Storage (UGS), the course describes the available historical archives of SAR images, allowing, even if not at full worldwide coverage, the estimation of surface deformation phenomena since 1992. The course concludes with a brief discussion of the new satellite sensors to be launched in the next few years and the new trends in data integration and visualization.

Participants’ Profile
The course is designed for anyone who would like to understand how satellite sensors can measure surface displacements to a fraction of a centimetre from space. It is not a course for radar specialists. Reservoir engineers, geophysicists, geodesists, geologists should all be interested in this new tool for surface deformation monitoring that is becoming more and more a standard. Radar data are still largely unknown but their impact on oil & gas and civil protection applications can be huge.
Engineering

PETROLEUM ENGINEERING • RESERVOIR MANAGEMENT • IOR/EOR •
Introduction to Heavy Oil: Genesis, Properties, Distribution, Recovery Technologies and Upgrading

**Instructor:** Dr Ali Shafiei (Nazarbayev University, Astana, Kazakhstan)

**Duration:** 1 day

**CPD Points:** 5

**Course level:** Foundation

**Course Description**
The course explores heavy oil, extra heavy oil, and bitumen, also known as viscous oil (VO), resource development including its genesis, physical and chemical properties, resources, reserves, geographical distribution, production, transport, upgrading, refining, future technology developments, and environmental impacts. There are over 9 trillion barrels of heavy oil, extra heavy oil, and bitumen oil known to exist in the world. By comparison, originally there were about 4.7 trillion barrels of conventional oil of which almost 1.2 trillion barrels have been processed to date. Canada and Venezuela alone possess over 30% of the world endowment. Since 1990 the VO in situ production industry has seen a number of startling advances. New production technologies, combined with developments in waste management, upgrading, monitoring and transportation have changed expectations. Now, it is a widely held view that 15-20% of the world’s VO resource base can be profitably produced with current technology; this ratio will rise as further technological advances are implemented. By 2030, VO’s contribution to the daily oil production will be about 17%. These figures show the importance of VO developments in the near future to fulfill a major part of the growing global demand for fossil fuels.

**Course Objectives**
Upon completion of the course, participants will be able to:
- Describe genesis, physical, and chemical characteristics, and geographical distribution of heavy oil resources around the world;
- Explain the major commercialized and emerging heavy oil recovery technologies;
- Recall some examples of heavy oil recovery operations;
- Describe major heavy oil upgrading technologies.

**Participants’ Profile**
The course is intended for engineers, geoscientists, and technologists active in E&P industry involved in exploration, production, transportation, upgrading and environmental management.

Streamline Simulation: Theory and Practice

**Instructor:** Mr Akhil Datta-Gupta (Texas A&M University, United States of America)

**Duration:** 3 days

**CPD Points:** 15

**Course level:** Foundation

**Course Description**
This course is designed to cover introductory and advanced concepts in streamline simulation and its applications for reservoir characterization, reservoir management and field development strategy. The specific topics covered will be:
- Streamline simulation: background and fundamentals;
- Streamline simulation: state-of-the-art and applications;
- Field case studies and experience;
- Streamline-based history matching and analysis;
- Advanced topics: fractured reservoirs and compositional simulation.

The course will combine theoretical discussion, practical applications and computer exercises to demonstrate the application of the methods.

**Participants’ Profile**
The course is designed for practicing geoscientists and engineers. No formal training in reservoir simulation is required other than knowledge of basic mathematics.
Value of Information in the Earth Sciences

DECISION MAKING  GEOSTATISTICS  INVERSION  MODELING
MONITORING  NOISE  RESERVOIR CHARACTERIZATION
ROCK PHYSICS  SEISMIC ATTRIBUTES  SENSORS  SIGNAL
PROCESSING  UNCERTAINTY

Instructor: Prof. Jo Eidsvik (Norwegian University of Science and Technology, Norway)
Duration: 1 or 2 days
CPD Points: 5 or 10
Course level: Intermediate

Course Description
The purpose of the course is to give participants an understanding of the multidisciplinary concepts required for conducting value of information analysis in the Earth sciences. The value of information is computed before purchasing data. It is used to check if data is worth its price, and for comparing various experiments. The course will outline multivariate and spatial statistical models and methods (Bayesian networks, Markov models, Gaussian processes, Multiple point geostatistics), and concepts from decision analysis (decision trees, influence diagrams), and then integrate spatial statistical modeling, geomodeling and decision analysis for the evaluation of spatial information gathering schemes. Unlike the traditional value of information analysis, this course focuses on the spatial elements in alternatives, uncertainties and data. A coherent approach must account for these spatial elements, and clearly frame the decision situation - we demonstrate a workflow for consistent integration and apply this in a series of examples. In this course we discuss and show examples of the value of imperfect versus perfect information, where the likelihood model of geophysical measurements is less accurate. We also discuss the value of total versus partial information, where only a subset of the data are acquired.

Course Objectives
Upon completion of the course, participants will be able to:
• Frame a spatial decision situation with alternatives, experiments and spatial geomodelling;
• Use a workflow to conduct value of information analysis in spatial situations;
• Interpret and compare the value of information of different spatial experiments.

Participants’ Profile
The course is designed for students, researchers and industry professionals in the Earth and environmental sciences who has interests in applied statistics and/or decision analysis techniques, and in particular to those working in petroleum, mining or environmental geoscience applications. Participants should have knowledge of basic probability and statistics, and mathematical calculus. Although it is not essential, it helps to know basic multivariate analysis and decision analysis or optimization. The participant must be willing learn statistical topics and earth science applications, and appreciate the multidisciplinary approach to solving quantitative challenges.

Uncertainty in Reservoir Management

ALGORITHM  PRODUCTION  RESERVOIR  RESERVOIR MODELLING
SAND  UNCERTAINTY

Instructor: Prof. Peter King (Imperial College London, United Kingdom)
Duration: 2 days
CPD Points: 10
Course level: Foundation

Course Description
The course will provide an introduction into many of the concepts behind uncertainty in reservoir modelling. It will start with a description of the origins of uncertainty with a mixture of heuristic treatments and more formal mathematical approaches. It will then develop the appropriate mathematical ideas and tools for estimating uncertainty in practical reservoir modelling. Finally, some ideas for how uncertainty can be managed will be explored.

Course Objectives
The aim of this course is to provide some of the basic statistical tools for quantifying uncertainty and some simple strategies for dealing with it.

Participant’s profile
The course is primarily addressed to reservoir engineers involved in building reservoir models but could also be of interest to production engineers who have to deal with the consequences of uncertainty in reservoir performance.
**Well Test Analysis**

Instructor: Prof. Shiyi Zheng (London South Bank University, United Kingdom)

Duration: 1 day

CPD Points: 5

Course level: Foundation

**Course Description**

This course on well test analysis will provide attendees with a basic knowledge on the subject. The course will start with a review of an oilfield life from exploration, appraisal, development and abandonment to define the role of well testing. The history and clear definition of the subject will also be given as an introduction summary. The course will cover classic, modern and numerical well testing concepts and techniques, where selected synthetic and field examples will be used throughout the course to demonstrate these concepts and application procedures.

**Course Objectives**

This one-day course was designed for reservoir engineers, production engineers, geologists, geophysicists and petrophysicists in order to master the basic theory and skills in well testing. This is an ideal introduction on the subject for those who knew nothing about this field before also beneficial as a knowledge update for those who have experience in well testing.

**Participants’ Profile**

Reservoir engineers, production engineers, geologists, geophysicists and petrophysicists. Participants would benefit from prior knowledge on well testing but this is not essential.

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**Handling Risk and Uncertainty in Mature Fields**

Instructor: Dr Mark Bentley (AGR TRACS International Ltd, Aberdeen, United Kingdom)

Dr Richard Oxlade (AGR TRACS International Ltd, Aberdeen, United Kingdom)

Duration: 1 day

CPD Points: 5

Course level: Intermediate

**Course Description**

The quantification of risk and uncertainty is often discussed in the context of exploration and appraisal, yet most of the upstream E&P business concerns decision-making in producing assets. Uncertainty-handling in development and production differs from that in E&A, as it must deal with a growing and often imperfect production data base against a backdrop of constantly changing circumstances. As the life cycle progresses, initial uncertainties over volume and productivity narrow but are supplanted by new uncertainties such as sweep efficiency, fine-scale architecture and changing responses to new production mechanisms and techniques.

This course explores the key aspects required to manage subsurface uncertainties and associated risks during the producing field life, in terms of People (identifying and avoiding common biases and heuristics that lead to poor decisions), Tools (making the best choice for given situations, balancing determinism and probability) and Approach (practical methodologies that avoid getting bogged down in unnecessary detail). The course closes with a set of questions to ask yourself and others, suitable for reference in informal personal or team assessments, peer reviews and peer assists.

**Course Objectives**

Upon completion of the course, participants will be able to:

- Clarify risk and uncertainty definitions;
- Summarize situations where statistical mistakes are typically made;
- Describe the tools commonly available for quantifying uncertainty and the pros and cons of each;
- Explain common sources of bias and how to overcome them;
- Lay out a strategy for handling risk and uncertainty that an integrated team could follow when working mature fields.

**Participants’ Profile**

Petroleum engineers working in mature fields (all disciplines) and co-workers involved in integrated teams.
Hydrocarbon Recovery

**Course Description**
The course provides an in-depth insight into the physics of hydrocarbon recovery. It first deals with hydrocarbon fluid properties and phase behaviour characteristics. Next, the interaction between hydrocarbons and porous media is discussed and the concepts of capillary pressure and (relative permeabilities) are introduced, followed by a discussion on the interaction between viscous, capillary and gravity forces at work in a hydrocarbon reservoir. After analytical descriptions of the displacement of hydrocarbons by water the basics of reservoir simulation are introduced. Subsequently, the displacement of hydrocarbons by water in relatively simple models with increasing geological complexities is discussed together with the concept of capillary equilibrium and its impact on recovery efficiencies. The contents of the course may vary a little depending on which region it is taught in.

**Course Objectives**
With the currently available computing power it is now possible to model both highly complex geological environments and highly complex hydrocarbon recovery mechanisms. In view of the enormous amount of data in reservoir simulation models there is an increasing tendency to have an unlimited belief in model predictions and omit the necessary quality checks on fundamentals. This course is aimed to (re)gain an in-depth insight into the fundamentals of hydrocarbon recovery in relatively simple geological models.

**Participants’ Profile**
Geoscientists who wish to obtain a good insight into the fundamentals of hydrocarbon recovery and the impact of geological heterogeneities on displacement efficiencies and reservoir engineers who wish to refresh their basic understanding of hydrocarbon recovery.
Data Science
New Applications of Machine Learning to Oil & Gas Exploration and Production

Instructor: Dr Bernard Montaron (Fraimwork SAS)
Duration: 1 day
CPD Points: 5
Course level: Foundation

Course Description
The course introduction will attempt to answer the question: How will A.I. change the way we work in the Oil and Gas industry in the coming years? Looking at what is underway in other industries and guessing what type of projects are under development in R&D departments in our industry will help answer that question.

Oil and Gas examples will be presented corresponding to each of the terms A.I., Machine Learning, and Deep Learning, allowing participants to reach a clear understanding on how they differ. The course will then focus on Deep Learning (DL) and address all key aspects of developing and applying the technology to Oil and Gas projects. This will be followed by live demonstrations of two DNN-based applications specific to Oil and Gas upstream domains.

Course Objectives
Upon completion of the course, participants will have acquired detailed knowledge of what deep learning is exactly, how it works, and in which way it differs from traditional neural networks that have been used in the industry during the last 30 years. They will understand which domains this can be applied to and for what type of applications. And they will also understand what are the main challenges, difficulties, and pitfalls when developing new applications. Finally, they will have seen demonstrations of deep neural networks applied to Exploration and Production disciplines and will be able to evaluate how useful the technology could be for their own domain.

Participants’ Profile
The course is designed for geoscientists, petroleum engineers, and petrophysicists from new ventures/basin, exploration, and development & production disciplines - from early career to senior, working in oil & gas companies or service companies.

Machine Learning for Geoscientists with Hands-on Coding

Instructor: Dr Ehsan Naeini (Ikon Science, United Kingdom)
Duration: 1 day
CPD Points: 5
Course level: Foundation

Course Description
In this course we attempt to layout the reality of artificial intelligence, machine learning, deep learning and big data. We cover the basic principles of machine learning and some of the most widely used algorithms. We continue by explaining a workflow for implementing a typical machine learning application in practice and to quality control and interpret the outcomes. Following this we shift focus to Geoscience and show various examples in which machine learning algorithms have been implemented for well- and/or seismic-based applications.

Given the hands-on coding nature of this course, trainees will code up a classification and a regression algorithm for lithology/facies and well log prediction correspondingly. Throughout these exercises the trainees will become familiar with the flexibility of coding machine learning in Python as well as familiarization with publicly available python libraries for machine learning and analytics.

Course Objectives
Upon completion of the course participants will be:
• Able to use python;
• Able to understand various machine learning algorithms, concepts and terminologies;
• Capable of analyzing data in big scales;
• Able to QC for machine learning applications;
• Able to extend their newly learned knowledge to their day to day practice and implement their own ideas.

Participants’ Profile
The course is designed for basically everyone.
Training and Development

HUMAN RESOURCES • SOFT SKILLS •
Mitigating Bias, Blindness and Illusion in E&P Decision Making

Course Description
Decisions in E&P ventures are affected by cognitive bias, perceptual blindness, and various forms of illusion which permeate our analyses, interpretations and decisions. This two-day course examines the influence of these cognitive pitfalls and presents techniques that can be used to mitigate their impact. “Bias” refers to errors in thinking whereby interpretations and judgments are drawn in an illogical fashion. “Blindness” is the condition where we fail to see an unexpected event in plain sight. “Illusion” refers to misleading beliefs based on a false impression of reality. All three—Bias, Blindness, and Illusion—can lead to poor decisions regarding which work to undertake, what issues to focus on, and whether to continue investing time, effort, and money in a given project.

The course begins by examining how these cognitive errors affect us. Several different errors are discussed, including: Perceptual Blindness; Illusions of Potential, Knowledge and Objectivity; and Anchoring, Availability, Confirmation, Framing, Information, Overconfidence and Motivational Biases. The second day includes a series of exploration and appraisal case studies resulting in both positive and negative outcomes. The course concludes by presenting a summary ‘toolkit’ with mitigation techniques that can immediately be applied to project work and decisions. This includes a laminated card listing the various types of bias, blindness and illusion on one side, and the six key steps to mitigate these cognitive errors on the flip side. This helps participants immediately apply the concepts to their daily work.

Course Objectives
Upon completion of the course, participants will be able to:
- Identify the influence of Bias, Blindness and Illusion on their analyses, interpretations and decisions;
- Apply techniques that will mitigate the impact of these in their project work and decision-making;
- Ensure that their behavior does not unwittingly reinforce these cognitive errors in others.

Participants’ Profile
This course is designed to have broad appeal to all levels and disciplines within an organization: junior to senior level geoscientists, junior to senior level engineers, analysts, landmen, HSE, HR, etc. And mid-level to senior managers and executives.

Attracting, Developing & Retaining Top Technical People

Course Description
The face of the industry has changed radically over the last 15 years with National Resource Holders increasingly replacing the once familiar “western style” major oil companies. In parallel we have embarked upon the “big crew change” with respect to staffing requirements as these national oil companies grow both at home but also compete internationally. The “expat” population that staffed those traditional western style companies is a dwindling resource due to the age demographic and cuts in headcount and research funding. And the industry has seen a strong transition towards the service companies for research and development. These service companies are expanding their technical and field management portfolios and looking for strong “nationals”, rather than expats, as their staff base.

It takes 10 years to educate and train entry level university students in the geoscience and engineering disciplines so they can effectively contribute to their companies with minimum supervision, so emphasis must be put on providing a pool of sound new recruits to be available to the industry, and the national resource holders and service companies are a big part of this equation. A further challenge is how to build and maintain skills once professionals have entered the industry.

This workshop considers how the upstream oil and gas business can make itself attractive to top level young geoscience and engineering undergraduates. It will consider the education they can be given in universities so they are most effective upon graduation, and at how to develop and retain them through their careers.

Course Objectives
Upon completion of the course, participants will be able to lay out a strategic plan to recruit and develop top graduates and plan their training programmes.

Participants’ Profile
The course is designed for Human Resources teams tasked with recruiting and developing staff for their technical departments.
Art of Science

Instructor: Dr Roel Snieder (Colorado School of Mines, United States of America)
Duration: 1 day
CPD Points: 5
Course level: Foundation

Course Description
Most graduate students receive their research training this way: by working with an academic advisor; the skills necessary for being an effective researcher are assumed to diffuse to the student. This happens to a certain extent, but the process is often inefficient and incomplete.

The course aims to fill this gap by specifically addressing issues that are needed to be effective in research. Topics that include the following:
• Choosing a research topic;
• Questions drive research;
• How to turn questions into a work plan;
• Goal setting;
• Turning challenges into opportunities;
• Ethics of research;
• Using the scientific literature;
• Communication;
• Publishing a paper;
• Time management;
• Writing proposals.

Course Objectives
Upon completion of the course, participants will be able to:
• Understand the considerations for choosing a research portfolio;
• Make a work plan for research that is underpinned by questions;
• Know common pitfalls and opportunities in research;
• Describe the elements of efficient oral communication;
• Comprehend fundamentals of time management.

Participants’ Profile
This course is aimed at junior researchers and their mentors in all fields of science and engineering.
Alphabetical list of short course instructors

Alaei, Behzad
Alkhalifa, Tariq
Avseth, Per
Barkved, Olav Inge
Barrier, Eric
Bentley, Mark
Berg, Janrik van den
Bertram, George
Bouska, Jack
Branston, Mike
Bruin, Jan de
Campbell, Allan
Cantrell, Dave L.
Carcione, José
Cherepovskiy, Anatoly
Christensen, Asbjørn Nørlund
Datta-Gupta, Akhil
Dentith, Michael
Doyen, Philippe
Dubrule, Olivier
Eidsvik, Jo
Eisner, Leo
Fayemendy, Cedric
Ferrari, Alessio
Ferretti, Alessandro
Fischer, Klaus
Fogg, Anthony
Galluccio, Laura
Gerritsma, Piet
Gisolf, Dries
Grana, Dario
Grechka, Vladimir
Haines, Thomas
Hasiuk, Franek
Hervanger, Jorg
Hobbs, Bruce
Hörnig, Sebastian
Huc, Alain-Yves
Ishutov, Sergey
Johansen, Tor Arne
Jones, Ian
King, Peter
Knackstedt, Mark
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Reiser, Cyrille
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Ronghe, Sagar
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Sayers, Colin
Schuster, Gerard
Shafiei, Ali
Shapiro, Serge
Socco, Laura Valentina
Soubaras, Robert
Stow, Dorrik
Swarbrick, Richard
Thomsen, Leon
Tyson, Stephen
Verschuur, Eric
Wiprut, David
Wygrala, Bjorn
Wynn, Tim
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