COURSE DESCRIPTION
The course is aimed at imparting working knowledge in Seismic Reservoir Analysis for geologists, geophysicists and reservoir engineers. At the outset, the course introduces briefly necessary concepts on seismic wave propagation, ray theory, attenuation and other propagation mechanisms associated with wave propagation, field data acquisition, and processing in land and marine environments.

The next section discusses seismic velocities (Vp, Vs), seismic resolution, fluid and rock properties, Direct Hydrocarbon Indicators (DHI), and Well Log analysis required for geophysical reservoir characterization,

The next section introduces the concept of Amplitude Variation with Offset (AVO) studies and how it can be applied for reservoir characterization using the intercept VS gradient cross plotting and Fluid Factor approaches.

Next section discusses how Acoustic Impedance (AI) inversion in the post-stack domain can be used to infer lithologic and reservoir fluid properties. In the pre-stack domain quantitative impedance attributes can be extracted that can provide significant controls on reservoir properties for determining hydrocarbon content. Lamda, Mu, Rho (LMR) attributes provide significant information about the rock and fluid types in the reservoir.

Next section discusses application of seismic attributes to derive information that can provide qualitative and quantitative constraints on reservoir properties. Post-stack single trace seismic attributes tend to provide information about the reservoir at the trace location. Multi-trace seismic attributes tend to provide information about reservoir geometry, structural and stratigraphic features of reservoir, and hydrocarbon indications in some situations. Dip, azimuth, curvature, and coherence attributes provide excellent controls on structural details. Instantaneous amplitude, frequency, phase, and spectral decomposition, provide information
about reservoir stratigraphy and hydrocarbon presence. Seismic attributes can be computed for mapped horizons, and in between horizons, to analyze interface and formation characteristics/properties.

Every day there will be exercises on computer/laptop to be brought by participants.

Recommended Participant Level: Entry Level Geologist, Geophysicist, Reservoir engineer, Petroleum Engineer. Those who have introduction to basic geology with college physics and math background, and with some experience in geoscience field in Industry.

Day 1
Necessary Concepts

- **Introduction**
  - Exploration for Hydrocarbons – The Big Picture
  - Wave Propagation, Compressional, and Shear Wave
  - Refraction, Reflection, and Diffraction
  - Reflection Time – Zero Offset, Non-Zero Offset
  - Reflection Strength from Interfaces
  - Reflection Polarity & Character
  - Partitioning of energy at an interface, Zoeppritz’s equations

- **Seismic Data Acquisition**
  - Land and Marine Data Acquisition
  - Concept of Common Depth Point Shooting, Multiplicity

- **Seismic Data Processing**
  - Practical Seismic Data Processing: Pre-Stack and Post-Stack
  - Amplitude Preserving Processing for AVO – for Inversion
  - Deconvolution – For improving vertical resolution
  - Stacking Velocity Analysis – for better structure imaging
  - Statics and Residual Statics - for removing structural artifacts
  - Migration - for repositioning reflection energy

Day 2
Seismic Velocities, Rock Physics, DHI and Well Logging Analysis

- Seismic Velocities Factors Affecting P & S-Wave Velocity; Empirical Relationships
- Average velocity, Interval velocity and Depth Conversion
• Seismic Resolution – Horizontal and Vertical
• Fluids Properties
• Rock Physics
• Fluid replacement modeling
• Rock Physics Templates
• DHI analysis - flat-spot, bright-spot, dim-spot, polarity reversal, chimney effects
• Fundamentals of well-logging analysis – Gamma, SP, Sonic, Density and Neutron
• Seismic to Well Tie – Synthetic Seismogram

Day 3
Reservoir Characterization through AVO
• Introduction to Amplitude Variation with Offset (AVO)
• Zoeppritz equation
• Approximations to Zoeppritz equation
• AVO classification – Class I, II, III, IV Sands
• AVO intercept/gradient crossplotting
• AVO – Geostack and Fluid Factor
• AVO in Carbonates
• Anisotropic AVO
• Discussion on the applicability and limitations of AVO

Day 4
Reservoir Characterization Using Seismic Inversion
• Geophysical Inversion Principle
• Convolutional trace model
• Acoustic Impedance Inversion
  o Recursive Inversion
  o Sparse spike inversion
  o Model Based Inversion
  o Colored Inversion
• Elastic Impedance Inversion
• LMR and Seismic Petrophysics
• Discussion on the robustness of AI/EI/LMR methods

**Day 5**

**Reservoir Characterization Using Seismic Attributes**

- Introduction to Seismic attributes
- Seismic Attributes
- Instantaneous Attributes
- Dip, Azimuth, and Curvature
- Coherence
- Spectral Decomposition
- Horizon and Formation attributes
- Seismic Attributes expression of Structure and Stratigraphy
- Integrating seismic attributes, AVO and AI/EI/LMR for reservoir characterization

**ABOUT THE INSTRUCTOR**

Kumar Ramachandran is an Associate Professor of Geophysics at the University of Tulsa. He worked with Oil and Natural Gas Corporation (ONGC), India for seventeen years before moving to academics in 2004. During his career with ONGC he worked with seismic, gravity and magnetic data acquisition, processing and interpretation aspects of hydrocarbon exploration in sedimentary basins in North India. Later he worked with Geological Survey of Canada and Queens University, Canada before joining University of Tulsa. He has a Master of Science Technology (Applied Geophysics) and Master of Technology (Petroleum Exploration) degrees from Indian School of Mines, Dhanbad, India, and a PhD in Geophysics from University of Victoria, Canada. His research and teaching interests are in detailing subsurface physical properties using geophysical methods for identification of hydrocarbon, water, mineral and coal resources. His current work in petroleum related research is focused on imaging reservoir properties through quantitative geophysics and artificial intelligence methods. He teaches industry courses at U.S.A., Mexico, Venezuela, Algeria, Turkey and India.

**ENROLLMENT**

In order to allow sufficient time for arranging travel plans, early enrollment is recommended. Registration will be closed on 22 September 2017. Late enrollment may result in course cancellation.

**CANCELLATION, SUBSTITUTION & REFUND**

The tuition fee will be refunded (less US$ 100 registration fee) only if notification of cancellation is received at least 10 days prior to the commencement.

Non payment of tuition fee does not constitute automatic cancellation of participation. Substitution may be made at any time for those enrolled.
CERTIFICATE

A certificate of participation will be awarded to each person completing the course.

TUITION FEE

Tuition fee at Rp. 37,000,000 + VAT per delegate (the tuition fee will be adjusted based on the prevailing rate) is due and payable upon confirmation of enrollment. The fee is excluded accommodation. Payment should be settled at the latest on 22 September 2017. Any bank charges connected with payment in Rupiah must be added to tuition fee payment. Tuition fee includes admittance to the course, course materials, daily refreshments and full lunch.

Payment can be made to PT.GEOSERVICES
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