Training Proposal

1) **Course Title:** Workflows for Seismic Reservoir Characterization

2) **Instructor:** Patrick Connolly

Patrick is consultant geophysicist specializing in seismic reservoir characterization with particular expertise in AVO methods and inversion including elastic and extended elastic impedance, seismic net pay and stochastic inversion. He is pioneer of several innovative concept and technology for seismic reservoir characterization. Patrick is the developer of Elastic Impedance (EI) and co-developer of Extended Elastic Impedance (EEI). He has more recently developed a Bayesian stochastic inversion tools (ODiSI) currently available as PETREL plug-in from CEGAL.

Patrick has 40 years industry experience, mostly with BP, retiring in 2015 as BP’s Senior Advisor for Geophysical Analysis. During his career he spent 15 years in research in both technology management and R&D project leadership, 10 years as an analyst/interpreter in exploration and appraisal teams, 10 years programming and 3 years as a data processor.

Patrick has been a SEG Distinguished Lecturer (2010), an EAGE Distinguished Lecturer (2007) and was the recipient of the 2001 SEG Virgil Kauffman Gold Medal.

3) **Course Duration:** 4 Days

4) **Course Description**

This course will provide participants with the skills needed to design and implement workflows for seismic reservoir characterization using established best-practice and emerging technology. The course covers seismic conditioning, coloured inversion, AVO theory including elastic and extended elastic impedance, DHI, seismic net pay, well ties, rock physics, and deterministic and probabilistic inversion including the new algorithm ODiSI.

This is a four-day classroom based course using examples, laptop based exercises and discussion. A complete hardcopy of the slides will be provided to each participant. This is a new course, first developed in early 2016, which Patrick has since delivered many times to multiple international oil companies.
5) **Who Should Attend**

The course will be delivered at an intermediate level. Participants should have a basic knowledge of the seismic method, including acquisition and processing with a minimum of three years working with seismic data. The subject matter of this course including, AVO and inversion is developed from basic principles.

The course will help practicing exploration and reservoir geoscientists, seismic QI specialists and seismic interpreters to utilize seismic more effectively in exploration and field development.

6) **Broad Outline of Course Content and Learning Objectives**

**DAY 1**

**Introduction**
- Introductions
- Technical and learning objectives

**Coloured Inversion**
- Bed thickness distributions
- Frequency domain implications
- Coloured inversion & blueing
- Optimising wavelets
- Frequency slice filtering
- Well ties and wavelet estimation
- Stratigraphic filtering
- Q & ghosts

**Exercises**
- 1D geological modelling with different bed-thickness distributions
- Wavelet modelling

**Learning Objectives**
- To appreciate the benefits of coloured inversion.
- To understand how and why coloured inversion works.
- To get the best results from a coloured inversion application.
- To get better well ties in a range of situations.
DAY 2

AVO
- Zoeppritz equations and linearisations
- Measuring AVO
- AVO and moduli
- Intercept-gradient combinations
- Elastic & Extended elastic impedance (EEI)
- Exploration risking
- AIGI crossplots and rock-physics templates

Exercises
- Half-space modelling with Wiggins, Dong, Fatti and Rüger equations
- Modelling gradient measurement errors
- Modelling intercept-gradient correlations
- Modelling EEI correlations
- Optimizing chi-angle stacks for different scenarios
- Modelling a seismic optimisation workflow
- Exploration risking using Bayes theorem

Learning Objectives
- How elastic parameters effect AVO response.
- Optimizing AVO products for subsequent characterization work.
- How to create seismic products that correlate with specific reservoir properties.
DAY 3

Attribute Maps
- Spectral decomposition
- Multi-attribute methods
- Reflectivity and impedance tuning
- Seismic net pay
- Uncertainties & limitations
- Map calibration

Exercises
- Demonstration of spurious correlation from multi-attributes
- Modelling how bandwidth affects tuning
- Manual estimation of net pay from synthetic attributes

Learning Objectives
- Appreciate the risks of using attributes with no physical relationship with desired objective.
- To understand how the seismic net pay method works and to be able to apply it effectively.
DAY 4

Seismic Inversion

- Integration & Uncertainty
- Bayes theorem
- Deterministic & probabilistic inversion
- Sources of uncertainty
- The inversion landscape
- One Dimensional Stochastic Inversion - ODiSI

Exercises

- Estimating values accounting for uncertainty
- Deterministic gradient descent inversion
- Stochastic inversion

Learning Objectives

- To understand the principles and pros & cons of deterministic and probabilistic inversion.
- How to select the appropriate inversion strategy for any given problem.