

Structural Geology for Petroleum Exploration & Production and the emerging Energy Geosciences

Professor Ken McClay

Short Course Program

This document outlines a 5 day classroom course of 10 half-day sessions. Each session will nominally consist of 2 -3 hours of presentations and 1 hour of exercises and case histories & discussions. The course focuses on the application of modern concepts of structural geology to hydrocarbon exploration and production. Emphasis is placed on the integration of data in order to determine the 4D evolution of structures, their seismic expressions as well as utilising case histories and natural examples as analogues for sub-surface hydrocarbon traps.

The presentations will be extensively illustrated with field and remote sensing examples, seismic sections, conceptual models and in particular analogue models of fault systems that demonstrate the progressive evolution of fault and fold systems.

Practical exercises and examples are excellent seismic examples of structural styles presented in a large format, A3 workbook. There will also be an A3 manual of the presentations and case histories discussed during the course.

Classroom presentation is preferred - this allows direct participant interactions & discussions

Day 1

Session 1. Fault systems in sedimentary basins

Introduction. Tectonic regimes; fundamental fault geometries & fault mechanics; fault growth, displacements & segmentation, characteristic map patterns & structural styles.

Session 2. Extensional fault systems I

Planar extensional faults - 2D & 3D geometries & evolutionary models; rift systems; extensional fault-related folds; Gulf of Suez - Red Sea, & NW Shelf case histories. Seismic exercises

Day 2

Session 3. Extensional fault systems II

Passive Margins - new models. Delta tectonics - gravity driven listric extensional faults. Southern margin examples and case histories. Seismic interpretation exercises.

Session 4. Extensional fault systems III

Extensional fault-related folding, uplift & exhumation, fault scarp degradation; extensional tectonics & hydrocarbon systems; Seismic interpretation exercises.

Day 3

Session 5. Inversion tectonics I

Tectonic of inversion terranes, analogue models & deformation patterns; Seismic exercises and case histories.

Day 3 contd....**Session 6. Inversion tectonics II**

Inverted rift basins & thick-skinned fault systems;
Hydrocarbon systems in inverted terranes. Seismic exercises & case histories.

Day 4**Session 7. Strike-slip terranes**

Tectonic settings of strike-slip systems; oblique convergence; transform faults. Characteristic structural styles, scaled physical models & case histories.

Session 8. Igneous systems in sedimentary basins and case histories

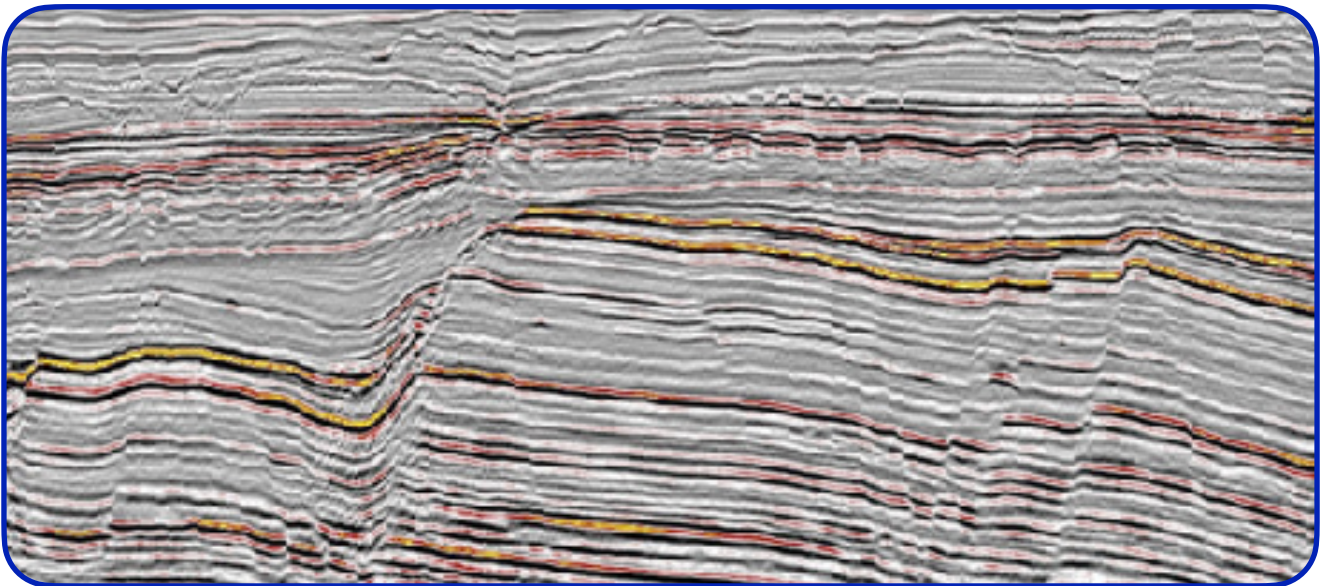
Exercises & examples using Australian basins - NW Shelf - Southern margin. Integrated workflows. Exercises & examples.

Day 5**Session 9. Fold & thrust tectonics I**

Sub-aerial fold & thrust belts, submarine fold & thrust systems - accretionary wedges, characteristic structural styles & map patterns; Seismic exercises & case histories.

Session 10. Fold & thrust systems II

Thrust fault-related folds, fracture systems & trap geometries, interpretation workflows. Exercises & case histories.



Extensional fault-propagation folds, Exmouth Plateau, NW Australia

Course aims

The aim of this course is to provide participants with the skills and knowledge required to apply the modern concepts and models of structural geology to the interpretation of 2D & 3D seismic data, to utilise field and remote sensing studies together with analogue and numerical models to develop templates for subsurface interpretations and analyses. An understanding of how faults, folds and fractures develop through time (i.e. 4D evolution) is critical to subsurface interpretations and mapping of hydrocarbon traps in sedimentary basins as well as for the challenges for CCSU and geothermal reservoirs.

Learning outcomes

By the end of the course participants will have an understanding of -

- - fault initiation, growth & linkage architectures
- - mechanisms of fault-related folding & fold growth
- - the kinematics and geometries of structures developed in rift systems
- - The kinematics and geometries of passive margins & delta systems
- - the kinematics and geometries of structures developed in inverted terranes
- - the emplacement of igneous bodies in sedimentary basins
- - the kinematics & geometries of fold & thrust belts
- - interpretation of thrust-related folds & trap geometries in thrust terranes
- - the workflows for seismic interpretation & integrated structural analyses.

Participants will have the ability to: -

- - recognise key structural styles on seismic data and on remotely sensed imagery & to identify the critical features that enable understanding the map patterns & their 4D evolution,
- - interpret structures in their broader geological context, & to understand the implications for regional tectonic evolution,
- - understand the implications for potential hydrocarbon bearing structures and for the structural complexity of existing fields,
- - understand modelling techniques, seismic imaging techniques and geometric concepts to test the validity of interpretations and to decipher the evolution of individual structures.



Slump folds & thrusts, Dead Sea margin

Professor Ken McClay

Ken McClay is an Adjunct Professor at the Australian School of Petroleum and Energy Resources at Adelaide University and Emeritus Professor of Structural Geology, at Royal Holloway University of London. He was director of the MSc in Tectonics at Royal Holloway and founder and director of the Fault Dynamics Research Group funded by the international petroleum industry. He has supervised numerous MSc, PhD and Post-Doctoral researchers, published widely in international peer-reviewed journals, written a book on mapping geological structures and edited five volumes on thrust tectonics and one on passive margins.



He has extensive worldwide field experience including in the UK, Canadian Cordillera, Alaska, the Basin and Range in SW USA, the Gulf of Suez and Northern Red Sea in Egypt, in Ethiopia, in Yemen, as well as in the Spanish Pyrenees, Chilean Andes, NW Argentina, Norway and Greece and the Zagros mountains of Iran.

His research interests include extensional, strike-slip, thrust and inversion terranes. A key aspect of his research is the integration of field studies, analogue models, seismic interpretation and remote-sensing in order to develop 4D evolutionary models for fault and fold systems in sedimentary basins. Current research projects include the tectonic evolution of the NW Shelf of Australia, passive margin architectures of the Australian Southern margin, the geodynamics of accretionary prisms and the emplacement of igneous bodies in sedimentary basins. He is a consultant for international petroleum and mining companies.

He has given many industry short courses including in - Indonesia, Singapore, Malaysia, Libya, India, Brazil, Chile, Argentina, Peru, Ecuador, Colombia, Norway, UK, Spain, USA, Australia, Egypt, Canada, Iran, Alaska, the Philippines, Papua New Guinea and Pakistan. He is a Fellow of the IMMM, a Chartered Engineer and Fellow of the Geological Society of London.



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