

N598: Geochemistry, Petroleum Systems Modelling, and Charge Evaluation

Instructor(s): Leon Dzou and Mark Thompson

Format and Duration

Classroom - 5 Days

Virtual - 10 Sessions

Summary

Participants will learn how to apply geochemistry in the evaluation of play fairways and prospects, integrating the regional geological framework with prospect evaluation principles and petroleum systems modelling. This will add value to exploration teams through more accurate resource estimation and charge risk assessment, ultimately drilling fewer dry holes or underfilled traps.

Learning Outcomes

Participants will learn to:

1. Understand the science that underpins petroleum migration and accumulation.
2. Assess the impact of the overall tectonic style in different mega-sequence settings, structural relief, and critically the role of faults and fractures in migration and trapping.
3. Apply the principles to make better predictions of charge access in prospect evaluation.
4. Evaluate the limitations and uncertainties inherent in thermal models.
5. Explain the challenges in assessing primary biogenic gas charge volume.
6. Employ bulk properties, gas chromatographic fingerprints, biological markers (GCMS) and carbon isotope data to undertake basic correlation of oil to oil and oil to source rock and to infer depositional environment of source rocks.

Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.

Who Should Attend

This course is aimed at geoscientists working on basin, play fairway, and prospect evaluation.

Course Content

Introduction

- Course overview
- Future directions in basin and petroleum systems modelling

Thermogenic source rock formation

- Thermogenic source rock evaluation (TOC, SI, S2, HI, Tmax, etc.,)
- Case history: Gulf of Mexico - nature and distribution of the various petroleum systems
 - Exercise: GoM Mensa gas field: did we miss thermogenic oil charge or is a source rock absent?
 - Exercise: Where are GoM Norphlet fields sourced from?

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Petroleum generation – maturation processes and thermal modelling

- Petroleum generation - maturation processes and kinetics
- 1D, 2D and 3D thermal modelling - basis of inputs required
 - Exercise: Thermal stress maps
- Case history: Western Canada Basin
- Case history: Williston basin 3D modelling study of the low-permeability petroleum system of the Bakken Formation
- The use of 3D petroleum migration modelling in exploration, how useful are these models in exploration risking and decision making?
- Alternative workflow for petroleum migration modelling – thinking processes to draw schematic charge cartoon, and then with appropriate software (percolation modelling).

Pressure, fluid flow and migration processes

- Pressure and fluid flow fundamentals
 - Exercise: Water flow – can you predict it on paper?
- Petroleum expulsion – primary migration processes
- An overview of petroleum secondary migration guiding principles
- Case history: Cooper Basin, Australia

Geological models (source-carrier-seal systems)

- GDE mapping (clastics and carbonate systems)
- Case history: Pearl River Mouth Basin, South China Sea
 - Exercise: where's the missing oil charge in southern PRMB?
 - Exercise: Lihua 11-1 field, what are the dominant factors favouring long distance transport of petroleum?
- Interpretations of stable isotopic composition of gases

Migration - entrapment

- Basin scale charge
 - Exercise: Alternative models source and seal
 - Exercise: Well failure analysis, Bintuni Basin, Papua New Guinea
- Case history and discussion: (Vertical drainage) petroleum system Marco Polo Field, Gulf of Mexico (charge focus, structure relief and seal capacity, migration time lag)
- Exercise: W Shetlands Basin Palaeocene discoveries

Role of faults

- Case history: Thunder Horse
- Trap configuration concept - evaluation of the capillary sealing capacity of all the seal rocks
- Case history: Columbus Basin, offshore Trinidad: use of fault-seal analysis in understanding

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petroleum migration in a complexly faulted anticlinal trap

Post well evaluation

- Case history: Norway and Equatorial Margin
- Exercise: Mexican Ridges
- Case history: Brigadier Trend and Ironbark well
- Exercise: Good luck, bad luck, and Mukluk
- Case histories: Using shows as a smoking gun

Prospect charge analysis

- Impact of DHI's on charge access risking
 - Exercise: Assess southern Mexico offshore exploratory wells charge access risk
- Charge assessment: procedures for estimating amounts of oil and gas generated, migrated, and trapped in prospects
 - Case history: Perdido Trend and Great White field, GOM
- Top capillary seal capacity evaluation workflow
- Case history: Frade and Roncador Fields, Campos Basin

Primary biogenic gas system

- Primary biogenic gas system – feedstock and how methanogenic archaeobacteria work
 - Exercise: Zohr gas field, Nile Delta Egypt
 - Exercise: biogenic gas charge assessment
- Gas hydrate deposits

Applications of petroleum geochemistry to exploration

- Petroleum geochemistry
 - Exercise: Using bulk geochemical data to determine source rock organofacies
- Oil–oil and oil–source rock correlation
 - Exercise: Geochemistry of crude oils from Eastern Indonesia
- Age diagnostic biological markers
 - Case history North Slope, Alaska
- Biodegradation effect on oil composition and secondary biogenic gas
 - Exercise: biodegradation risk in North Sea
- CO₂ pollutant gas
 - Exercise: CO₂ risk in Song Hong Basin

Concluding remarks and summary of best practice