

N320: Prospect, Trap and Fault Seal Analysis: Mapping Key Uncertainties (*Miri, Malaysia*)

Instructor(s): Titus Murray and Howard Johnson

Format and Duration

Field - 5 Days
Moderate Physical Demand

Summary

Increasingly leads and prospects are smaller and closer to seismic resolution - the use of straightforward mapping and structural techniques can take these prospects to successful discoveries. In many cases significant fault dependencies mean mapping and fault seal analysis are key to estimating trapped columns, fluid contacts, volume and risk. Students will learn how a map works or fails as well as quantitative techniques to test multiple dependencies and complex fault interactions. Field excursions will examine the scale and structure of a real oilfield and explore fault geometries and trapping mechanisms.

Learning Outcomes

Participants will learn to:

1. Appraise fault geometries and estimate throw uncertainties to better constrain potential prospects and traps.
2. Develop quick look techniques for structural maps and in order to assess whether a map works or fails for a faulted prospect.
3. Assess prospects and traps and map their structural closures to accurately assess fluid volumes and fluid contacts.
4. Estimate the risks associated with stratigraphic juxtaposition and sealing likelihood across faults.
5. Integrate structural and mapping techniques to determine complex fault interactions and dependencies.

Training Method

A five-day combined field and classroom course, the proportion of field to classroom time is around 50:50. Lectures with numerous exercises (some involving paper mapping) and simple structural techniques will be augmented by field visits to examine real rocks involved in an active petroleum system and a local oilfield.

Physical Demand

The physical demands for this course are MODERATE according to the Nautilus field course grading system. The field stops are not strenuous. There is no ascent more than 10 m (30 ft) and no walks longer than 2 km (1.25 miles) at sea level. However, the environment in north Borneo is tropical, hot and humid and this elevates the grading from LOW to MODERATE. Participants should be prepared for temperatures over 30°C (85°F) and 100% humidity - such tropical conditions are not tolerated well by some people. Lightweight loose clothing is recommended and long sleeves and trousers will protect against biting insects.

Who Should Attend

This course is relevant to all geoscientists who are engaged in the assessment and appraisal of prospects and trapped hydrocarbon volumes and who require a better understanding of the controls on faulted

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traps.

Course Content

Increasingly the leads and prospects explorers are looking at are smaller and closer to seismic resolution. The course involves a ‘back-to-the-future’ approach and through the use of straightforward mapping and structural techniques participants will gain the skills to take their prospects through to successful discoveries.

In many cases, prospects have significant fault dependencies. Thus mapping and fault seal analysis are critical to estimating trapped columns, fluid contacts, volume and risk.

During the training, common sense, easy-to-use techniques will be used to assess faulted prospects. The ability to see how a map works or fails to work as a prospect will be a key skill students will be expected to leave the course with. These ‘quick look’ skills will be augmented in the field where they will explore fault geometries, associated trapping mechanisms and uncertainties to give strong visual memories of fault to take into prospect evaluation.

As well as the ‘quick look’ techniques there will be time to develop quantitative techniques to make, test and break prospects. In particular, the consideration of multiple fault dependencies and the ability to hand-contour complex fault interactions (relay ramps, branch lines and soft-linked faults) that may be required to get a prospect to work. At the end of the training participants will have the skills both to produce better prospects of their own and to help peer review prospects of others.

Provisional Itinerary and Agenda

Day 0: Arrival

Attendees arrive in Miri, Sarawak. Check in to hotel. Introduction to the course, participant and tutor introductions and aspirations, Nautilus field safety briefing, housekeeping.

Day 1: Introduction to scale of structures and trap analysis. Regional and Intraformational Seals

Introductory lectures – Course Objectives, Introduction to the geology of NW Borneo and Sarawak

Field excursion to the Lambir Hills to introduce local stratigraphy and sequence stratigraphy. Examination of potential regional and intraformational seals in the field. Sedimentary aspects of seal integrity.

Groups will ultimately present 4 prospects. In a scenario exercise that will run through the training participants will be split into groups to help present, mature and rank a series of prospects.

Day 2: Juxtaposition and SGR analysis

Morning field excursion – visit to the Miri Field and Canada Hill to understand the scale of a real prospect.

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Airport Road outcrop – examination of fault geometries and faulting at a variety of scales, does my fault seal?

Afternoon classroom session - Participants will build the skills to work confidently on exploration fault seal analysis. In particular, understanding when and how to use Juxtaposition and SGR analysis.

- Fundamentals of rock mechanics and structural geology
- Reservoir connection – trap analysis, trap elements, Allan Maps. Exercises
- Traps – Defining dependencies, connected volumes, perched water. Exercises
- Seal – Exploration fault seal, seal and Allan Maps, calibration, SGR and juxtaposition.

Teams will be introduced to their prospects and go through a cursory ranking process.

Day 3: Pressure and fault seal analysis

Morning field excursion – visit local outcrops in Miri to examine a variety of fault types in a heterolithic succession.

Afternoon classroom session - Participants will be introduced to the impact and risks associated with hydrodynamic seals and how they differ from membrane fault seal. A key feature of fault seal analysis is the identification and modelling of uncertainty associated with the measurement, interpretation and mapping of faulted horizons. Students will gain the skills to quickly and efficiently identify fault uncertainties.

- Review – SGR and Allan Maps
- Pressure seals – hydrodynamics, break-over
- Uncertainty – Sources of uncertainty: geological, interpreter, measurement, map analysis. Exercises
- Uncertainty – Fault geometry, throw:length ratios. Fault kinematics and mechanics.

Exercises

Day 4: Fault statistics and revising the prospect

Morning field excursion – Field exercises will give students practical understanding of the variations in fault geometry relative to the size of the fault. Analysis of fault statistics at outcrop (throw/heave/shape).

Afternoon classroom session - Group prospects will be updated using the practical skills learned during the training. With a prospect defined there will be a review of the geomechanical and charge issues that could then limit the accumulation size.

- Review – Pressure and uncertainty
- Top seal – Trap integrity geomechanics, bulk rock volume
- Charge risk
- Prospect evaluation – Update map, assess fault juxtapositions, define trapped columns.

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Exercises**Day 5: Presentation of team prospects, summary**

Field work on the final day will be used to explore the field evidence for geomechanical mechanisms that can diminish trap efficiency and thus reduce trapped columns.

Afternoon classroom session - Students will go through a "Peer Assist" review of their prospects to re-rank and help define the drilling order for the prospects.

- Review – geomechanics and charge
- Present group prospects

Final wrap up and course evaluations

Day 6: Departure