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How to Interpret Multi-well Pressure vs. Depth Plots & Pressure Maps from DST & Wire-line Formation Test (WFT) data

**12 – 16 March 2012, Kuala Lumpur
28 May – 1 June 2012 Perth**

23-24 April 2012,
Kuala Lumpur, Malaysia



PGCE 2012
Petroleum Geoscience Conference & Exhibition



**Your Expert Trainer:
Hugh Reid**

Hugh is internationally recognized for his DST related expertise and his training courses, which have been presented bi-annually in Calgary and overseas in over 17 countries, representing more than 200 companies over the past 23 years. He has over 30 years' experience in DST analysis and hydrodynamics, 8 years with Mobil Oil in Calgary.

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About this training course

This 5 day intensive training course will show participants how to use pressure data from DST's, Wire-line Tests (such as RFT's & MDT's) & production Tests (from many different wells) to make Pressure/Depth Plots which reveal permeability barriers such as pinch-outs, sealing faults & any barrier which can trap hydrocarbons.

It will also examine how pressures can be used to help correlations between wells & determine if sands are separate or connected. Also covered is how to find fluid contacts from limited single hydrocarbon pressure points by independently finding the fluid gradients from lab fluid analyses & correcting to subsurface conditions.

Six class projects give hands-on experience. Students practice skills using data before each pool was discovered & then assess how big the pool is using the discovery well pressure data.

5 Day Course Outline in Summary

- Introduction and history of use of pressure data in exploration
- Sources of pressure and salinity data: DST's – Drillstem Tests, Production Tests, RFT's – Wireline Tests
- Screening the data
 - How to obtain valid stable pressures from the data
 - How to distinguish mud filtrate from true formation water
 - How to determine correct subsurface fluid gradients
- Using pressure/depth graphs to correlate reservoirs (Are zones continuous or separate?)
 - How to predict gas/oil/water contacts downdip from new discovery wells
 - How to make potentiometric surface and pressure maps
 - How to find permeability barriers (stratigraphic) traps from pressure drops in the reservoir
- Identifying areas of updip and downdip flow
- Tilted oil/water contacts
- Capillary pressures
- Identifying 'flushed' areas
- Hydrodynamic traps (accumulations without any apparent seal)
- Causes of pressure anomalies – underpressure and geopressure
- Using chemical water analysis to correlate zones – Stiff diagrams
- Modern concepts – pressure compartments

Who Should Attend

Production & Development Geologists, Engineers, Petro-physicists & operations people working to extend existing fields. This course will also benefit exploration geologists who are involved in looking for permeability barriers & subtle traps missed by others in well drilled basins where most of the structural traps have already been found using seismic but stratigraphic traps are still not all discovered.

Past testimonials

"Enjoyed case histories HANDS-ON... that's the way to learn!"
Dave Garner, Geologist,
Chevron, Calgary.

"Hundreds of examples and hands-on, data gathering very very good, great teaching style".
David Cairns, Geologist,
Shell, Calgary.

"All materials were well organized & clearly presented with many refresher lessons"
Dasapta Erwin Irawan, Lecturer ITB Bandung Indonesia

"Course benefits from instructor's wide experience"
Peter Eadington,
Principle Scientist,
CSIRO, Sydney.

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5 DAY COURSE CONTENTS IN DETAIL

Day One

Introduction and history of use of pressure data & in exploration & field development including finding permeability barriers & assessing trap holding capacity

- ❖ Fundamentals of Pressure –Depth Plots (P/D plots)
- ❖ Relationship between P/D plots & pressure maps
- ❖ Concepts of Buoyancy & Capillary pressure

Using pressure/depth graphs to correlate reservoirs (are zones continuous or separate?)

- ❖ Sources of pressure and salinity data:
DST's – Drill stem Tests, Production Tests, WFT's– Wire-line Formation Tests eg. RFT's MDT's etc

Screening the data

- ❖ How to obtain valid stable pressures from the data.
- ❖ How to determine correct subsurface fluid gradients independently using water, oil & gas analysis & correcting surface measured density for temperature & pressure to subsurface conditions.
- ❖ Importance of GOR (gas/oil ratio) & API gravity in oil gradients.

Review of some case histories of using Pressure/depth plots to solve common geologic /oilfield situations:

- ❖ Helping in Correlating Sands.
- ❖ Separating gas pools incl. fields straddling an international border. Are they separate or one huge field? (using evidence from production history, P/D plots & other data)
- ❖ Mapping continuous porosity trends by pressures
- ❖ Review of Interesting MALAYSIAN published case history (1995 SPE paper) of “Hidden Oil Leg” in Dulang field (Initial early pressure data did not reveal any Oil Column (only Gas) but later drilling showed 75m oil column !

Day Two

Class Project 1

DEFINING A STRATIGRAPHIC TRAP WITH PRESSURE DATA (800 MM BBL. OILFIELD)

in Middle Devonian Sd. Northern Alberta Canada (Mitsu Oilfield)

For this project: Students start with raw data from eleven separate wells and progress through all steps to completed map.

A reservoir pressure/continuity map is made to define major sand pinch-out edge. Raw pressure/fluid data prior to discovery is utilized.

- ❖ It will be shown how the oilfield could have been initially missed due to a false pressure from an old DST.
- ❖ Students will predict down-dip oil water contact & extent of field from discovery DST pressure to decide land acquisition strategy. This project occupies most of the day & students learn use & accuracy of old data & which gauge to select for most useable pressure & how to screen out false pressures where packer fails & other mechanical problems.
- ❖ They will learn how to calculate a minimum oil column from ONE oil pressure point where the GOR & hence oil gradient is unknown.

Class Project 1A

HOW TO FIND GAS WATER CONTACT FROM ONLY 2 PRESSURE POINTS

Case history where operator has run 2 DSTs in a reef. Upper DST flowed gas & lower DST only water **BUT** DST tools were stuck in hole & had to be fished out so poor tight hole conditions meant the operator had to run casing **BEFORE** any logs or RFTs could be run so oil water contact was unknown. Students have to find the gas/water contact using a plot & verify by computation using a simple useful cookbook procedure.

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Day Three

Regional pressure Depth plots of basins to show major sub-crop edges: Facies changes & barriers

Resource Plays

- ❖ How to identify large areas of Gas continuity in deep parts of basins (Central Basin Gas)
 - Examples of over-pressured & under-pressured fields with immense thousand foot columns & significance in Formation
- ❖ How the trap formed & how many traps leak at present

Using chemical water analysis to correlate zones & to find out if a zone has suffered deep filtrate invasion – Stiff diagrams

- ❖ Hydrodynamic traps (accumulations without any apparent seal)

Class Project 2

FINDING GIANT BUT SUBTLE GAS RESERVES in Triassic W. Canada

- ❖ Students given a few small isolated (1 Bcf.) gas pools with interspersed “water” tests.
- ❖ Gas pressure continuity exercise shows mis-correlation by industry.
- ❖ Pools really form one huge accumulation and “water” was filtrate.
- ❖ Now over 70 wells drilled with 1 Tcf reserves!
- ❖ Spectacular recent example of hydrodynamics used as gas finding tool.

In this project the students integrate the tools of Pressure Depth plots, Formation water analyses, together with logs & cuttings/core descriptions to identify the field

Project also shows industry missed field because reservoirs were damaged & suffered deep filtrate invasion masking log characteristics & affecting DST results

Day Four

How to identify Updip vs Downdip flow from P/D plots & how to tell if a trap will leak from pressure data

- ❖ Capillary pressures & sealing capacity of traps for oil & gas under static conditions
- ❖ How to predict potential oil or gas columns that a seal will hold
- ❖ Effect of Hydrodynamic flow on Trap holding capacity
- ❖ Up-dip flow & stratigraphic trap flushing
- ❖ Down-dip flow & trap enhancement mechanism
- ❖ Examples of huge stratigraphic traps with weak barriers but big reserves due to down-dip flow eg. San Juan Basin, Elmworth, & Milk River/Medicine Hat giant fields W. Canada

Class Project 3

IDENTIFYING FLUSHED VS. PROSPECTIVE AREAS in Williston Basin

Students make regional potentiometric surface maps to define flow direction in Middle Dev. Winnipegosis, and assess completed maps in other zones.

These identify:

- ❖ Broad non-prospective areas of up-dip flow where few fields occur.
- ❖ Enhanced areas of Down dip flow where many huge fields occur
- ❖ Unconformity Traps
- ❖ Mechanism of trapping
- ❖ Poor quality of many unconformity surfaces (often weathered zones)

Enhancement by presence of good quality seals over-lying the unconformity surface OR a higher pressured reservoir un-conformably overlying a lower pressure sub-crop reservoir

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Defining Pressure regime in sub-cropping beds vs. Overlying beds & looking for pressure sinks showing down-dip flow from overlying zone into sub-cropping zone & locally trapping huge oil columns

Class Project 4

PROSPECTING FOR A FAVOURABLE UNCONFORMITY TRAP in Midale- Weyburn & Steelman Fields, Williston Basin (US –Canada border area)

Students make Potentiometric map of Miss Carbonate which truncates against Red Beds with poor sealing capacity (low entry pressure) yet traps a huge oil column

- ❖ Map reveals trapping mechanism
- ❖ Students compute trap holding capacity of seal from entry pressure & Capillary buoyancy pressures which reveals traps holds more than seal will hold revealing importance of intra formational flow along the unconformity surface into the sub-cropping reservoir preserving the huge oil 600 ft oil column despite the weak seal which can only support 100 ft oil

Day Five

Class Project 5

HOW TO RAPIDLY ASSESS AN UNFAMILIAR OVERSEAS BASIN FOR STRATIGRAPHIC & FAULT TRAPS USING REGIONAL PRESSURE PLOTS & MAPS.

- ❖ Regional study of a Middle East or S.E. Asia basin undertaken.
- ❖ Will show the permeability distribution.
- ❖ Highlight areas of stratigraphic traps to test.
- ❖ Determine if faults are sealing or leaky
- ❖ Determine if hydrodynamics can cause observed tilted oil/water contacts in existing fields.

Tilted Oil Water contacts

- ❖ Causes & Mechanisms of tilting;
 - Hydrodynamic Flow
 - Change in grain size & capillary properties across a pool
- ❖ Why it is hard to tilt gas & easier to tilt oil due to buoyancy differences
- ❖ How oil production can cause local hydrodynamic flow & induce tilts of contacts
- ❖ Worldwide examples of tilted pools incl. Kutei Basin Indonesia, N. Africa, & N. America

Class Project 6

An existing pool in North Africa has tilted oil water contact. Students map flow direction across the pool & compare to the map of tilt of Contact. Project will show mechanism/cause of tilt.

Other Multi Well Pressure techniques & Plots.

Plots of Reservoir pressure vs. Saturation pressure (Bubble point) & Saturation Pressure vs. Depth for different pools.

- ❖ These show the hydrocarbon migration paths between pools & reveal fossil reservoir pressures at the time of migration. Since fossil reservoir pressure depends on depth, the old depth of aquifer at time of migration is revealed.
- ❖ Principles of Differential Entrapment, Migration history.

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Your Expert Trainer: Hugh Reid

Hugh Reid operates an international petroleum consulting practice in Calgary, Canada. He specializes in hydrodynamics studies and Test interpretation. He has broad experience in teaching Courses in DSTs, Pressure vs. Depth Plots & Hydrodynamics to the international petroleum industry, having presented in over 10 countries, representing more than 150 companies over the past 25 years.

He has also filled a niche in the Canadian petroleum industry by providing advice on DSTs, independent of service company affiliation. Hugh received a B.Sc.(Geol.) from the University of Bristol, U.K. in 1968. He has over 30 years' experience in DST analysis and hydrodynamics, 8 years with Mobil Oil in Calgary and over 20 years as an independent DST analyst, including 4 years as technical manager for Delta P Test Corp. (specialized closed chamber DST's in tight gas sands - U.S. Rocky Mountain region).

He is a past president of the Canadian Well Logging Society and was a co-chair of the AAPG Hedberg conference on hydrodynamics at Banff, Alberta, and is an active member of the SPE, CSPG, CIM, AAPG & APEGGA. He is the author of various DST manuals and technical articles on testing and hydrodynamics, including co-author of the first IPA paper on this topic in Indonesia. His regional pressure studies have covered areas of Indonesia (Salawati Basin & South Sumatra basin) as well as Libya and North America.

"Instructor breaks a complex subject into simple to understand modules, well organized".

Dave Love, Geologist,
Husky

"Will help to evaluate underpressured reservoirs"

Jeremy Burkhart
Exploitation Engineer Devon Energy

"Lot's of Info but not overdone"

Lori Dwyer ,Geologist, Conoco Phillips

"I plan to use these concepts on a daily basis in work. I wish I'd taken the course earlier"

Marsha Giesen , Geologist
Husky Energy

About **petroEDGE**

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Course Name & Venue	EARLY BIRD	✓	NORMAL	✓	TEAM DISCOUNTS
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Department : _____

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Email : _____

Delegate 2

Mr Ms Mrs Dr Others: _____

Name : _____

Job Title : _____

Department : _____

Telephone No. : _____

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Company : _____

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Please note

- Indicate if you have already registered by Phone +Fax +Email +Web
- If you have not received an acknowledgement before the training course, please call us to confirm your booking.
- Photocopy this form to register multiple delegates.

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Make Payable to Asia Edge Pte. Ltd.

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