



Basic Logging Methods and Formation Evaluation

Instructors: Gary W. Batcheller
Level: Basic - Intermediate
Duration: 5 days

Target Audience

Professionals in geosciences drilling, production, and completion technology utilize this program. This practical class will be a good application of logs for all with previous experience an excellent introduction for those who have had little application of logs before

Course Objectives and Description

This 5 day course is conducted in two parts of theory and practice with hands on experiences on modern technologies of well logging methods and formation evaluation. General principles of physics are presented first to explain the behavior of modern logging tools in order to provide good understanding of logging fundamentals for subsequent data acquisition and interpretation techniques. Log quality control issues will be addressed adequately. Complementary and simplified exercises are included in the foundation part to help transfer learning knowledge of each topic to the participants. A distinct feature of this course, is the application of actual log examples for reservoir illustration, description of properties and formation evaluation. Case studies will be provided in the second part for deeper illustration of concepts and log analysis in a workshop-lecture setting. As such, students gain practical knowledge of log interpretation by working with comprehensive exercises and actual log examples from sandstone and carbonate formations throughout the world. Various characteristics and depositional settings will be discussed. Coordinated and pre-structured examples in excel spreadsheet will be provided to students for proper applications. Students are encouraged to bring their own examples to share with the class on the final day and apply skills learned to address logging problems and interpretation to their own field cases.

Learning Outcome

- Identify potential reservoirs and how they are related to geology
- Determine mineralogy, porosity gas effect and water saturation
- Learn application and limitations of logging tools including quality control issues
- Apply quick look methods of formation evaluation and log analysis with provided Excel spreadsheets
- Combine theory, applications and exercises through interactive techniques and workshop environment.



Course Contents

PART 1 - LOGGING AND FORMATION EVALUATION PRINCIPALS

DAY 1

- **INTRODUCTION**
 - Logging objectives
 - Invasion profile
 - Effects of drilling overbalanced
 - Applications and limitations of logging
 - Determining potential reservoir Rocks
 - Traps versus “Resource” Rocks
 - Reservoir Types – Conventional vs. Unconventional
 - Logging While Drilling (LWD) Concepts
- **BASIC PETROPHYSICAL PARAMETERS AND MODELS**
 - Natural radioactive in clays
 - Electrical conductivity of earth materials
 - Formation resistivity or conductivity factors
 - Resistivity, porosity and water salinity relations
 - Resistivity and fluid saturation relations
 - Permeability relationships between particle size and distribution
 - Examples
 - Complementary exercise
- **WELL LOGGING MEASUREMENT ENVIRONMENT**
 - Reservoir/Non-reservoir discrimination
 - Determining when permeability exists
 - Effects due to near wellbore environment
 - Temperature and drilling underbalanced
- **OPEN HOLE LOGGING TYPES**
 - Spontaneous Potential (SP)
 - Gamma ray and spectral gamma ray
 - Resistivity/Conductivity logs
 - Sonic logs
 - Density logs
 - Neutron logs
 - Formation testing
 - Elemental logs (Spectral analysis)
 - Magnetic Resonance logs



- Dipmeters
 - Examples
 - Complementary and basic exercises
- **LOGGING TOOLS AND DATA ACQUISITION**
 - Basic principles
 - Wireline
 - Logging while drilling (Real time data versus memory)
 - Logging through drill pipe
 - Examples
 - Complementary and basic exercises

DAY 2

- **OPEN HOLE LOGGING INTERPRETATION AND APPLICATION**
 - Resistivity measurement methods and various depths of investigation
 - Porosity applications for lithology and mineralogy indications
 - Porosity determination in “clean” formations –for liquid and known lithology
 - Utilizing effects of clay and gas to improve porosity estimations
 - Improved mineralogy Identification with cross plots
 - Limitation of using Archie equation
 - Shaley sand saturation versus Archie equation
 - Quick-Look methods for determining the presence of hydrocarbons
 - Overview of permeability and calculations for sedimentary rocks
 - Determination of flushed zone resistivity and hydrocarbon mobility
 - Class group exercises using real examples
 - Mechanical properties of rocks (Drilling and hydraulic fracturing applications)
 - Unconventional reservoir analysis (Resource reservoirs) and thermal maturity
 - Total organic carbon (TOC)
 - Examples
 - Complementary exercises

DAY 3

- **LOG QUALITY CONTROL METHODS**
 - Repeatability versus tool limitations
 - Effects due to time and temperature
 - Additional near well bore environment effects
 - Comparison to know information such as surface logging, offset production etc
 - Comparing logs on the same wellbore
 - Comparing available offset log data
 - Usefulness of calibrations



- Example
- Complementary and basic exercises
- OVERVIEW OF CASED HOLE FORMATION EVALUATION
 - Cased hole compared to open hole
 - Cased hole logging operation limitations
 - Major categories of cased hole logging.
 - Pulsed neutron methods compared to open hole logs
 - Mineralogy log applications
 - Potential resistivity log applications
 - Examples
- WIRELINE FORMATION EVALUATION TESTING
 - Overview
 - Limitations of formation testing tools
 - Application of formation testing tools
 - Fluid characterization (filtrates versus formation water)
 - Examples
 - Complementary exercise

PART 2 – APPLICATIONS AND EXPERIENCES

DAY 4

- HANDS ON EXERCISES WITH LOG DATA (USING EXCEL)
 - Porosity calculation
 - Shaley sand saturation calculation
 - Lithology determination
 - Mechanical rock properties from sonic and density logs
 - Detection of potential depletion in pore pressured
 - Calculate permeability logs using cores
 - Estimate rock stress profile with sonic and pore pressure
 - Various clay volume calculations
 - Pay and reservoir quality estimates
 - Complete case study including production results

DAY 5

- FIELD CASE STUDIES - (PROVIDED)
 - Shaly sand example
 - Difference in reservoir quality



- Potential hydrocarbon zones
 - Computer –Aided Interpretation important inputs
 - Importance of verifying log quality
 - Reasons for Success and failures
 - Lessons learned
- CLASSROOM PARTICIPANT’S FIELD EXAMPLES AND PROBLEMS
- FINAL COMMENTS AND CONCLUSIONS

Course Delivery

- The course is conducted as 3 days of lecture serious to set the foundation, followed by 2 days of workshop style exercises and case studies. Heavy interactions between the instructor and participants are expected based on past experiences of teaching the course.
- The foundation part will have complimentary and simplified exercises as well in order to enhance the learning of participants and get them ready for the workshop part.
- A complete set of our in-house Excel-based computer programs will be provided to the trainees for performing the hands-on exercises in the workshop
- Actual field case studies will be discussed throughout the workshops, and participants will become familiar with practical aspects and issues of logging and formation evaluation in field cases.
- Participant’s project cases or examples could be addressed

Other Course Logistics

EXERCISES

- Exercises will also form an integral part of this course during the first 3 days of lecturing on foundations. Major topic of the course will have complementary exercises for deeper understanding of foundations.
- The course will offer an in-depth workshop on practical logging an formation evolutions, using actual filed data. Participants will solve problems and will do comprehensive hands-on exercises on practical problems, as described in the outline.

SOFTWARE

- EXCEL (the regular suite of MSOffice software)
- Our in-house automated Excel-based computer programs with field case logging cases for

COMPUTER

PC laptop with normal storage capacity and with Microsoft Excel