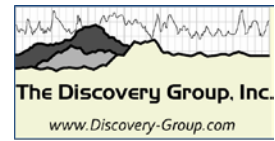


# Basic Openhole Log Interpretation

Daniel A. Krygowski, Senior Petrophysical Advisor, The Discovery Group



*The Discovery Group offers courses in petrophysics for your people, at your location, at a date convenient to your needs and internal schedules. The courses will benefit geologists, engineers, geophysicists, and geotechs, and can be of benefit to other specialists who routinely work with those geotechnical specialists. The best class size is from about 10 to 25 people from a variety of specialties who can share their professional experiences in the context of a greater understanding of petrophysics.*

## Synopsis:

“You’ve got to get the fundamentals down, because otherwise the fancy stuff is not going to work.”  
(Randy Pausch, 2008, *The Last Lecture*)

*Basic Openhole Log Interpretation* is about getting the fundamentals down, where “the fundamentals” are about the common openhole logging measurements, the borehole conditions in which they can be run, and their interpretation in the geologic environments for which they were designed. Once those interpretations are understood, one can move to the range of “unconventional” targets which are being pursued today, and better understand the response of those common measurements (and their limitations) in today’s exploration and production targets.

The course covers the measurements that are available in millions of existing wells worldwide and addresses the response of those measurements which are being made in wells being drilled now. New and specialty measurements along with their developing interpretations (“the fancy stuff”) are also addressed in the course.

While some knowledge of petrophysics and well log interpretation is helpful, people having no experience with well logs have expressed strong benefits from taking the course. For those with experience gained over time, the course has helped consolidate that experience and set scattered pieces of knowledge in a framework that provides a better overall understanding of existing and developing petrophysical technology.

## *The course:*

- Offers a “hands-on” approach to basic openhole well log analysis and interpretation;
- Focuses on the traditional interpretation targets of lithology, porosity, and fluid saturation;
- Introduces a variety of interpretation techniques in the context of the availability of newer, more extensive, data;
- Is organized by the targets, or goals of the measurements, rather than by the physics of the measurements.

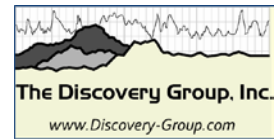
The course strives to provide a strong and coherent foundation for the understanding of other specialized interpretation techniques involving well log data, which are not covered here.

## *Course topics include:*

- An overview of petrophysical well log data acquisition;
- Description of the common openhole measurements; acoustic, nuclear, and electrical;
- Determination of lithology, porosity, fluid saturation, and other properties from those measurements;
- Use of algorithmic and graphical techniques to determine those properties from the measurements that are made;
- Interpretation exercises to reinforce the interpretation methods that are covered.

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**Length:** Three days (The course length can be extended to allow the inclusion of other topics, to delve into listed topics more extensively, or to address the specifics of interpretation for current areas of interest of the client company.)

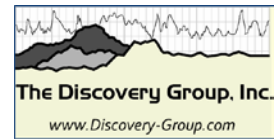
**Equipment needed:** Calculator with exponent functions, straight-edge, pencil or pen. Computer with Microsoft Excel (to be used in small groups) for the last exercise of the course, on the last day.

Topics for each of the log measurements follow the same sequence and information:

- Measurement goals
- Physics of the measurement, including the volume of investigation
- Operational parameters; conditions under which the measurement is best made
- Measurement names; tool and curve names from different vendors
- Log example; usually in the context of other measurements
- Interpretation details; details of the measurement goals
- Secondary effects: the environments and assumptions which affect the measurement and its interpretation
- Environmental corrections
- Quality control
- An exercise related to the primary interpretive goal

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**Agenda:** No specific times are listed, as the times to cover material will depend on the questions and comments of the class. Questions and comments based on the experience of participants are welcomed and encouraged, and often provide insights to local conditions and methods that would otherwise not be presented.

Short breaks will be taken throughout the course, as needed.

## Day 1

- Course logistics
- Introduction
- Correlation/Reservoir logs
  - Gamma Ray
  - SP
  - Caliper
  - Tension
- Porosity and Lithology
  - Introduction

## Day 2

- Porosity and Lithology, *continued*
  - Acoustic/sonic
  - Density (bulk density and photoelectric effect)
  - Neutron porosity
  - Porosity measurement combinations
    - Porosity pair crossplots
    - Neutron-Density QuickLook
    - Porosity triads (RHOMaa-Umaa, RHOMaa-DTmaa, M-N)

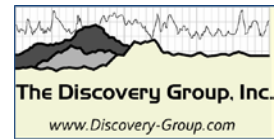
## Day 3

- Resistivity
  - Introduction
  - Deep resistivity (including a brief look at interpreting old E-logs)
  - Microresistivity
- Fluid saturation
  - Archie's saturation equation
  - Bulk volume water
  - Pattern recognition techniques
    - Pickett, Hingle, Buckles plots
    - Using the techniques in concert (PickettHingleBuckles gameboard)
- Specialty measurements\*
  - Nuclear magnetic resonance (NMR)
  - Gamma ray and neutron spectroscopy
  - Triaxial resistivity
  - Dielectric/Electromagnetic propagation

\*While course materials are available for the Specialty Measurements, those measurements will be covered as time permits, and based on the interest of course participants. It is possible that the material in this section will not be covered in the available class time, but class notes on these topics will still be distributed as part of course materials.

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### About the instructor:



**Daniel A. Krygowski** is a Senior Petrophysical Advisor at The Discovery Group, in Denver, Colorado, USA. In this role, he has worked petrophysical interpretation projects in a variety of international and US domestic locations. Currently he is spending most his time providing and developing training courses in basic and intermediate openhole petrophysics. The courses include the common instructor-led formats, as well as longer-term, lower intensity formats that allow participants to spend more time with the course material while delving deeper into areas of personal interest.

Since the late Cretaceous, Dan has taught the AAPG Basic Well Log Analysis course with Dr. George Asquith. In recent years, Rick Lewis, with Schlumberger, has joined George and Dan in instruction in the course. In 2004, the AAPG published *Basic Well Log Analysis*, co-authored by Dan and George, with Steve Henderson and Neil Hurley. The book is the second edition of George's similarly-named book which was one of AAPG's all-time best sellers, and the second edition has also become an AAPG best seller.

Dan earned a BA in Physics from the State University of New York at Geneseo. He then earned MS and Ph.D. degrees in Geophysics from the Colorado School of Mines, where he focused on petrophysics under Dr. George R. (Dick) Pickett.

After completing his formal education, Dan worked for Cities Service Company (now part of Occidental Petroleum), Atlantic Richfield (now part of bp), Petrophysical Solutions, Landmark Graphics (a Halliburton company), and Chevron. At several of those companies, he held positions in petrophysics and petrophysical software development, with both technical and management responsibilities. He joined The Discovery Group in late 2006.

Dan has been active in the Denver Well Logging Society, serving two terms as Director, and terms as Vice-President Technology, and Vice-President Membership. Dan is a member of SPWLA, AAPG, SPE, SEG, DWLS, and RMAG.

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