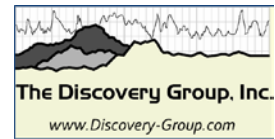


## Beyond Porosity: Lithology from logs

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:

Over several decades in the mid-20<sup>th</sup> century, several logging measurements were invented, which we call “porosity” measurements. In fact, the measurements respond to porosity only indirectly, with lithologic and fluid parameters needed to make the transition from the actual measured quantity to porosity.

This course assumes a basic understanding of those common openhole measurements; acoustic slowness, bulk density, photoelectric effect, and neutron porosity. The course considers pairs and triads of those four measurements in predicting lithology and providing a better estimate of porosity than by using any of those measurements individually.

The course ends with an introduction to elemental spectroscopy, which can produce a much more complex model of the lithology, but which is highly dependent on the assumptions made by the interpreter.

### *The course:*

- Offers a “hands-on” approach to the prediction of lithology from openhole measurements;
- Focuses on the interpretation of lithology, including shale volumes and complex lithologic mixtures;
- Introduces a variety of interpretation techniques in the context of the availability of newer, more extensive, data;
- Starts with simpler interpretations and moves to more complex interpretations using newer measurements.

The course strives to build on the existing understanding of petrophysical interpretation techniques to recognize common lithologies at a glance, improve lithologic interpretations with a minimum of effort, and provide some understanding of what petrophysical software does “under the hood.”

### *Course topics include:*

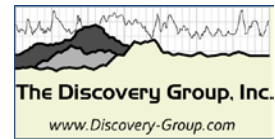
- A quick review of the physics of the measurements to be discussed;
- Determination of the volume of shale or clay. The schools of thought and the terminology;
- Determination of lithology and better estimates of porosity through crossplots and QuickLook techniques;
- Determination of more complex lithology through M-N Plots and MID Plots (apparent matrix plots);
- The issues involved in the determination of lithology from elemental spectroscopy.

*Length:* One day

*Equipment needed:* Calculator with exponent functions, straight-edge, pencil or pen.

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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

- Physics of the measurements

  - Gamma ray, SP

  - Sonic traveltime, bulk density and photoelectric effect, neutron porosity

- Determining the volume of clay or shale in the formation

  - Schools of thought; needed data; tradeoffs

  - Using gamma ray, SP, neutron porosity and bulk density

- Discovering lithology and porosity

  - Crossplots: lithology pairs and porosity

  - QuickLook methods

  - Mineral triads:

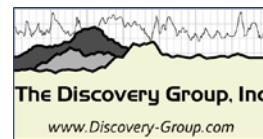
    - M-N Plots and MID Plots

- Lithology from elemental spectroscopy

- Wrap-up

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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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