The Discovery Group offers a course in the petrophysics of unconventional reservoirs for your people, at your location, at a date convenient to your needs and internal schedules. The course 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: The course assumes a basic understanding of common openhole logging measurements and interpretation, and uses that working knowledge to expand the measurement responses and interpretation of those responses into the environments for which the measurements were not originally designed. Exercises provide the means to put the information shared here into practice.

The course:

- Offers a “hands-on” approach to the interpretation of tight gas sands and organic shales;
- Looks at traditional reservoir properties; porosity and fluid saturation, in the context of unconventional environments
- Introduces a variety of interpretation techniques in the context of the availability of both older and newer more extensive data;

The course strives to build on the existing understanding of petrophysical interpretation techniques in the context of subsurface environments described as “unconventional”.

Course topics include:

- An overview of the properties of organic matter, and how those properties change with maturity.
- A review of methods to determine lithology from common openhole logs.
- Coalbed methane.
- Tight gas sands:
  - Summary of the key petrophysical properties;
  - Computation of shale volume, total porosity, and effective porosity;
  - Determination of fluid saturation through shaly sand models.
- Organic shales:
  - Summary of the general petrophysical approaches for analysis;
  - Determination of lithology, TOC, porosity, and fluid saturation;
  - Free and adsorbed gas, and gas in place;
  - Deterministic and stochastic approaches to interpretation.
- Suggested workflows for specific unconventional resource types.

Length: Two days

Equipment needed: Calculator with exponent functions, straight-edge, pencil or pen, colored pencils
Laptop computer with Microsoft Excel (to be shared in small groups)


**Petrophysics of Unconventional Reservoirs**

Robert M. Cluff, President, The Discovery Group

**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**

**Morning**
- Introduction to unconventional workflows
- QuickLook lithology from logs – a review
  - **Exercise 1:** Lithology and porosity from a neutron-density crossplot
  - **Exercise 2:** Lithology and porosity from a neutron-density QuickLook
- Coalbed methane
- Tight gas sandstones I – Vshale and porosity
  - **Exercise 3:** Vshale from gamma ray

**Lunch**

**Afternoon**
- Tight gas sandstones II – water saturation, Sw
- Introduction to mudstone reservoirs, shale gas, and tight oil
- TOC estimation from logging measurements
  - **Exercise 4:** TOC from deltaLogR

**Day 2**

**Morning**
- TOC estimation from logging measurements (finish, if needed)
  - **Review of Exercise 4**
- Mudstone mineralogy from cores and multi-mineral log models
- Mudstone porosity and fluid saturations
  - Exercise 5: Computing grain density from a multi-mineral solution

**Lunch**

**Afternoon**
- Oil- and Gas-In-Place calculations
  - **Exercise 6:** OGIP calculation
- Net pay, drainage area, effective height

Synthesis and Review
About the instructor:

Bob Cluff is a geologist and petrophysicist with over 35 years experience in oil and gas exploration, development, and research. His principal areas of expertise are petrophysics, petroleum geology of carbonate and clastic reservoirs, and the integration of petrophysical data with geological data in detailed reservoir studies. He has worked and published extensively in the fields of non-conventional gas from both tight sandstones and shales, petrophysics, source rock analysis and basin modeling. He has conducted and supervised projects in most sedimentary basins of North America as well as South America, Europe, Southeast Asia, and Australia.

Bob received his BS degree in Geology from the University of California at Riverside (high honors) and an MS in Geology from the University of Wisconsin at Madison. He has taken additional graduate and undergraduate studies in geology, physics and mathematics at the University of Illinois at Urbana-Champaign, University of Colorado at Denver, and Metropolitan State College of Denver. From 1976 to 1981 he was a geologist with the Coal and Oil and Gas Sections of the Illinois State Geological Survey, worked as an independent consulting geologist from 1982-1986, founded The Discovery Group in 1987.

Bob is active in several professional societies including the American Association of Petroleum Geologists, Society of Petroleum Engineers, the Rocky Mountain Association of Geologists (past-President 2006), the Denver Well Logging Society (past-President), and the Society of Petrophysicists and Well Log Analysts (Vice President Technology; Vice President Membership, Regional Director North America).

He is a registered geologist in the states of Texas (1873), Illinois (196-000177), and Wyoming (313), and is a DPA Certified Petroleum Geologist (3168).

Bob can be contacted at:

RobertCluff@Discovery-Group.com
303.831.1515 x11