

Joint PTTC/Eastern Region SPE Workshop

Applied Petroleum Geology and Geochemistry for Thermogenic Shale-Gas Evaluation – A Primer for Engineers and Scientists Focused on Marcellus Exploration and Development in the Appalachian Basin

To be presented by

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Wednesday, September 23, 2009
Charleston Civic Center, Charleston, WV

Workshop Summary

The Potential Gas Committee's most recent estimated natural gas reserves for the United States surged upwards by 35 percent from 1,532 Tcf in 2006 to 2,074 Tcf in 2008 (Mouawad, 2009). This is the largest increase in the 44-year history of reports from the committee, and is due in large part to advances in drilling and developing thermogenic shale-gas reservoirs in Texas, Pennsylvania, and elsewhere. Shale-gas provides only a small fraction of the nation's total gas production, but the rising supply of this resource means that it could substitute for other fossil fuels as conventional reserves decline.

The successful and efficient evaluation of shale-gas reservoirs in the subsurface requires a thorough understanding of petroleum geology, geophysics, and geochemistry. In particular, various aspects of shale petrology and petroleum geochemistry provide fundamental information that is critical to finding and developing unconventional shale reservoirs. Shale-gas reservoirs vary from tight, low-permeability rocks to highly-fractured rocks with variable bulk mineralogical composition which controls the ductile versus brittle fabric of the shale. It is necessary to determine if natural gas stored in shales is microbial or thermogenic in origin in order to predict the likelihood of economic shale-gas production. Finally, it is critical to apply geochemical measurements and interpretations in the context of geologic characteristics to the decision making process in shale-gas exploration and development.

Many of the petrologic and geochemical tools needed for shale-gas evaluation are unfamiliar to scientists and engineers trained in conventional petroleum geology. The purpose of this workshop is to introduce these tools and explain how they are used to evaluate shale-gas reservoirs and resources, with specific examples from and emphasis on the Marcellus Shale in the Appalachian basin.

Workshop Topics

- Natural gas – origins and characteristics
- Conventional versus unconventional petroleum reservoirs

- Characteristics of unconventional shale-gas reservoirs
- Objectives of shale-gas reservoir assessment:
 - Core to geophysical log calibration
 - Gas-in-place determination
 - Past production and performance matching
 - Future production forecasting
- Petrology and geochemistry of shale and shale-gas: analytical programs and interpretations:
 - Total organic carbon (TOC)
 - Measurement
 - Applications
 - Inorganic petrography:
 - Optical mineralogy
 - Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS)
 - X-ray diffraction
 - Applications
 - Organic petrography:
 - Reflectance and fluorescence microscopy
 - Kerogen types and evolution
 - Vitrinite reflectance (R_o)
 - Hydrocarbon types and thermal maturation
 - Applications
 - Rock-Eval Pyrolysis:
 - Definitions
 - Quantity of organic matter
 - Quality or type of organic matter
 - Thermal maturation of organic matter
 - Applications
 - Biomarkers
 - Natural gas isotope geochemistry
 - Hydrocarbons
 - Non-hydrocarbons
 - Noble gases
 - Applications
- The Marcellus Shale:
 - An overview
 - Selected case studies
- Summary

Instructor Bio

Christopher D. Laughrey is a Senior Geologic Scientist at the Pennsylvania Geological Survey where he has worked since 1980. He studied geology and geochemistry at the University of Pittsburgh and has taught graduate classes in sandstone petrology there. He also has taught professional workshops in carbonate petroleum reservoirs, shale

petrology, and petroleum geochemistry for the Appalachian region Petroleum Technology Transfer Council and for PetroChina through GMRE Inc., a consulting geologic firm in State College, Pennsylvania. Laughrey worked as a geophysical analyst for the Western Geophysical Company of America in Houston, Texas before taking his present position in Pittsburgh, Pennsylvania. His special interests include organic and isotope geochemistry, applied sedimentary petrology, borehole geophysics, and karst geology.

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