

Course Code

GC01

Course Title

Petroleum Geochemistry: Basic Concepts and Applications to Oil and Gas Exploration and Exploitation

Instructor

Dr. R. Paul Philp



Professional Career

Dr. Philp has been a Professor of Petroleum and Environmental Geochemistry at the University of Oklahoma since 1984. Prior to that he worked with CSIRO in Australia. He graduated with a Ph. D. from the University of Sydney in 1972. His research encompasses many areas of petroleum and environmental chemistry and he has published and presented numerous papers at national and international meetings. In addition he has taught a number of Petroleum and Environmental Geochemistry courses to many companies including Yacimientos Petroliferos Fiscales, Argentina; China at invitation of Academia Sinica to lecture at various institutes and universities; Japanese National Oil Company in Tokyo; Petrobras, Brazil; New Zealand Geological Survey; INTEVP - Caracas, Venezuela; Taiwanese National Oil Company, Taipei; Tanzanian Petroleum Development Corporation, Dar-es-Salem, Tanzania; Peruvian National Oil Company; ARAMCO, Saudi Arabia; Ecopetrol Colombia; Petronas Malaysia; Indonesian Petroleum Association; Shengli oil field China; Petrovietnam, Hanoi and Ho Chi Minh City; Sonatrach, Algeria.

Course Objective and Description

Petroleum geochemistry evolved rapidly in the period 1970-2000 and is now a mature discipline widely used in many aspects of petroleum exploration. If one thinks of the petroleum system, petroleum geochemistry plays a role in characterizing the source rocks, evaluating thermal history of the source rocks and whether they have matured enough to generate oil or gas, monitoring migration pathways and playing a significant role in reservoir characterization.

The initial part of this course will review the basic concepts of organic geochemistry and their application to petroleum exploration, reservoir, and production problems. It will also provide a review of various aspects of organic and analytical chemistry necessary for completion of this course. Developments which have had a significant impact on exploration studies include source rock characterization in terms of source, maturity, depositional environments; crude oil characterization, including various alteration processes; oil/oil and oil/source rock correlations; primary and secondary migration mechanisms and distances will be discussed.

In the second part of the course we will utilize many of the basic concepts described above and apply them to various aspects of natural gas exploration and exploitation. This area has seen a lot of interest in the past few years, driven in part by the interest in production of gas from non-conventional reservoirs. The geochemical techniques used for this purpose and how they are applied to improve production from these non-conventional resources will be described in detail.

In brief this course will review all the basic and applied aspects of petroleum, reservoir, and production geochemistry. Examples will be described showing where these approaches have been used part of actual case studies. Current and future developments will also be discussed along with their potential impact on exploration and production studies.

Who Should Attend

This course is designed primarily for exploration geologists, geophysicists, production and reservoir engineers, and geochemists that have had some introductory courses in organic or petroleum geochemistry. It is anticipated that the participants would have at least a B.S. degree, or equivalent, in Geology or Chemistry plus some exploration related experience. However many of the basic techniques used in geochemical studies will be described in sufficient detail for participants to obtain an understanding on the fundamentals behind the use of these techniques.



Prerequisite

Some basic chemistry and geology would be useful but not essential. Similarly education to the B.S. level would be useful but experience in some aspect of exploration would be very useful.

Learning Level

Undergraduate to graduate level.

Duration

5 days

Course Material

The course material will consist of hard copies of the power point presentation plus and CD and copies of a number of important and relevant papers that will be discussed in the course.

Course Outline

Day One

In order to understand any organic geochemical concept, it is necessary to provide a brief overview of the basic geochemical concepts and chemical structures used in the field. Techniques needed to obtain the necessary analytical data will be described prior to discussing the topics summarized below.

- Formation of Organic Rich Source Rocks.
 - o What is a source rock?
 - o What are the requirements for a good potential source rock?
 - o Productivity, Preservation, and Accumulation
 - o Why are some types of organic matter better preserved than others?
 - o How does the nature of the depositional environment control the preservation of the organic matter?
 - o What is the role of the mineral matrix in the preservation of the organic matter?
 - o What type of organic matter produces oil and what produces gas?
 - o Why do we get these differences?
 - o How are the different kerogen types related to the type of organic matter?
 - o Biomarkers-what is a biomarker? How are they detected and how are they used to characterize sourcerocks?
 - o Organofacies and organolithofacies

Day Two

- Types of source rocks
 - o Variations in the characteristics of shale vs. carbonate source rocks
 - o Variations in the products generated from the two types of rocks
 - o Potential problems in characterization and distinguishing oils from the two types of source rocks
- Maturation and degradation
 - o How does organic matter in a source rock change with increasing maturity?
 - o How do the products generated from a source rock change with increasing maturity?
 - o How can we use our geochemical parameters to monitor changes in maturity both in oils and source rocks?
 - o What are the most reliable parameters and their maturity range
- Source rock evaluation methods
 - o TOC
 - o Rock evaluation
 - o Petrographic characterization
 - o Vitrinite reflectance
 - o Thermal alteration index
 - o Hydrous pyrolysis
 - o MSSV characterization
- Generation of oil & gas
 - o Time of generation, expulsion, quantities generated and expelled.
 - o Parameters required to determine timing of oil generation; time vs. temperature effects.
 - o Use of rock evaluation parameters in basin modeling
 - o Expulsion efficiencies

Day Three

- Crude oils
 - o Characterization of crude oils
 - o Crude oil types
 - o Utilization of biomarkers for crude oil characterization
 - o Correlations based on bulk parameters
 - o Oil/oil and oil/source rock correlations
 - o Biodegradation and other alteration processes
- Basin modeling studies
- Derivation of geochemical parameters used as input for basin models
- Natural gas source rocks
 - o Conventional gas source rocks
 - o Mechanisms of gas generation
 - o Unconventional gas shales

Day Four

- Sources of gaseous hydrocarbons
 - o How can we look at the gas samples and get information on maturity and whether the gas was associated with oils at low level of maturity or much higher maturity levels required for cracking the oil to gas?
 - o How can we look at associated condensates to get maturity related information?
 - o What models are available for predicting generation levels of gas samples?
 - Non-conventional gas resources
- Non-conventional gas resources have become a very important exploration topic in the past few years. Many of these unconventional sources are found in shales previously designated as oil source rocks. However large amounts of gas are trapped in these shales and released by significant fracturing operations. Geochemistry plays a major role in determining the potential of these shales to produce gas; regions of the shales mature enough to have produced gas; mechanisms of generation; distinguishing free v. adsorbed gas; maturity modeling. These topics will be discussed with examples from a number of non-conventional resources.
- o Shale gas
 - o Maturity mapping of gas shales
 - o Relationship between lithofacies and gas content

Day Five

- World-wide exploration and production case studies
- In the preceding parts of this course, information has been provided to give the participant sufficient information to understand how source rocks are formed; how they are characterized and evaluated; how this information can be incorporated into various basin models; why some source rocks produce oil and some produce gas.
- In this final section of the course, examples will be provided from selected areas world-wide to illustrate where all of this information has been integrated to evaluate and characterize oil and gas source rocks. Areas selected for discussion will include the following.
- o North Sea, UK
 - o Mahakam Delta, Indonesia
 - o Qaidam Basin, China
 - o Talara Basin, Peru
 - o Song Hong Basin, Vietnam
 - o Anadarko Basin, Oklahoma

Antalya, Turkey
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