

THE ROLE OF WELL LOGGING IN FORMATION EVALUATION

Zaki Bassiouni

Department of Petroleum Engineering, Louisiana State University, Baton Rouge, Louisiana, USA

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Summary

This chapter underscores the role of well logging in the detection and evaluation of petroleum reservoir rocks. It also introduces the different facets of well logging technology and the different types and classification of well logs. The use of open hole logs is emphasized. The concept of each of the major log is discussed using typical cases. A systematic step by step analysis is presented in sandstone and carbonate formations. The three examples included address both oil-bearing and gas-bearing formations.

1. Introduction

Formation Evaluation is a sub-discipline of both Petroleum Engineering and Geosciences. Formation Evaluation specialists acquire, prepare, and when required analyze data needed by other practitioners in the areas of exploration, drilling, production, and petroleum reservoir characterization and management. Formation Evaluation techniques encompass:

- Reservoir rock sampling and analysis,
- Reservoir fluids sampling and analysis,
- Well pressure and flow tests, and
- Well logging.

Well logging technology is subdivided into three distinct, yet intertwined, facets:

- 1) Measuring formation parameters in a well of interest. These measurements, referred to as "well logs", are used to determine the hydrocarbon potential of intervals intersected by the well. The measurements process itself, usually referred to as "running a log" or "logging a well", are performed by service companies who also design, build, and calibrate the logging tools.

- 2) Formation parameters displayed by a well log do not directly indicate the hydrocarbon potential of a zone. They need to be transformed into porosity and fluid saturation values. The equations and algorithms used in the transformation have been arrived at by petrophysicists. Petrophysicists continuously identify formation parameters which can be measured in a well bore and relate said parameters to key reservoir characteristics.
- 3) The task of combining log measurements and petrophysical algorithms to ascertain the hydrocarbon potential of a formation is referred to as log interpretation or log analysis. Involved log interpretation is performed by a log analyst. However, because well logging data is used in all aspects of petroleum exploration and production, all petroleum engineers and petroleum geoscientists are familiar with well logs and perform analysis directly related to the area of their practice.

Log data is used for qualitative and quantitative analysis. Qualitative interpretation consists of the formation rock typing e.g. sandstone, limestone, etc., formation fluid typing e.g. water, oil and/or gas. Quantitative interpretation consists of assigning values to the thickness of hydrocarbon zones, its porosity and hydrocarbon saturation i.e. the values needed to calculate the amount of oil and/or gas in place.

Well logs are classified according to a) the physical property they measure e.g. electric, acoustic or nuclear logs, b) the time in the life of the well at which they are acquired e.g. logs measured while drilling, logs measured after drilling, but before casing the well bore (open hole logs), and cased hole logs.

This essay focuses on the concepts and analysis of open hole logs. Understanding the concepts and analysis of open hole logs can easily be extrapolated to other log types.

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Biographical Sketch

Dr. Zaki Bassiouni is a Professor Emeritus of Petroleum Engineering, *Louisiana State University*. He was a professor and chair of the Craft and Hawkins Department of Petroleum Engineering from July 1983 to June 2004 and Dean of the College of Engineering from 2004 to 2008. Dr. Bassiouni received a B.S. in Petroleum Engineering from Cairo University, a diploma in Geophysics from the Ecole Nationale Supérieure de Petrole et des Moteurs of Paris, France, and an M.S. (DEA) and Ph.D. (Docteur Es Sciences) from the University of Lille, France.

Dr. Bassiouni is an active member of the Society of Petroleum Engineers (SPE). He was selected by the society as Distinguished Lecturer for the 2004-05 season and 2008-09 season. He is the author of the Society of Petroleum Engineers Textbook Series Vol. 4 "Theory, Measurement, and Interpretation of Well Logs." Dr. Bassiouni was also selected as the 2006 recipient of the SPE Formation Evaluation Award. This award recognizes outstanding achievements and contributions to the advancement of petroleum engineering in the area of formation evaluation.

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