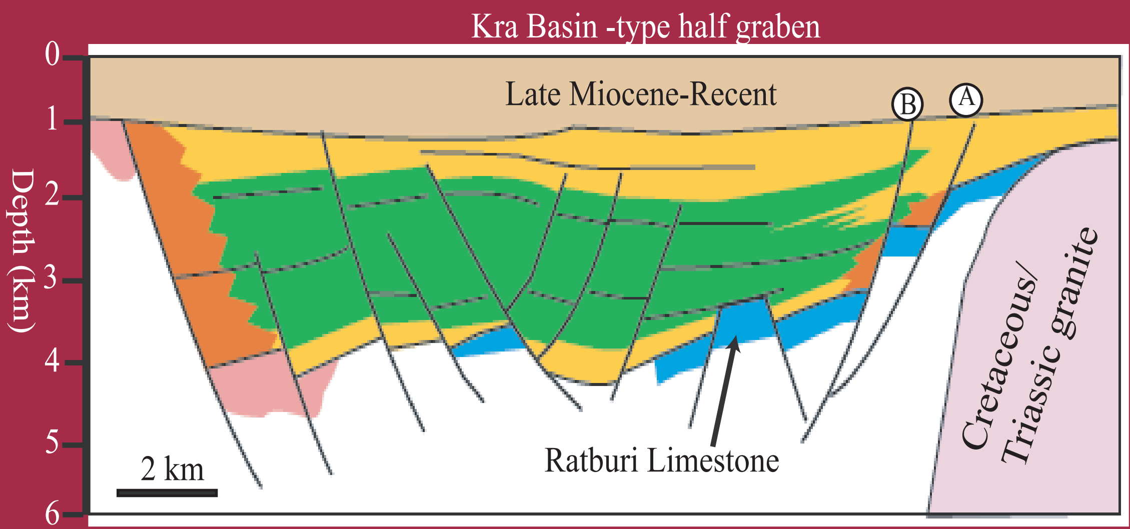
Bulletin of Earth Sciences of Thailand (BEST)

Volume 3 Number 2 October 2010

BEST

International Journal



Petroleum Geoscience

ISSN 1906-280X

Bulletin of Earth Sciences of Thailand (BEST)
International Journal of Earth Sciences

Bulletin of Earth Sciences of Thailand (BEST) is an international journal and publishes peer-reviewed works across the geosciences and earth sciences disciplines from fundamental theory and sciences to applied research of relevance to sustainable management of the environment.

ISSN: 1906-280X

Cover: A schematic model of the Kra Basin (page 3)

Editorial office:
Department of Geology, Faculty of Science, Chulalongkorn University, Phrayathai Road., Bangkok 10330, THAILAND.
Telephone: 66-2-218-5445, 218-5442-3 Fax: 66-2-218-5464
Website: http://www.geo.sc.chula.ac.th/geonew/Page/BESTjournal.php Editor Email: monkeng@hotmail.com

Preface

The Bulletin of Earth Sciences of Thailand (BEST) has established itself as an international academic journal of the Geology Department, Chulalongkorn University (CU) since the year 2008. This Number 2 issue of Volume 3 is devoted specifically to the publications contributed by the International Petroleum Geoscience M.Sc. Program of the Geology Department, Faculty of Science, CU for the academic year 2009/2010. Certainly this Bulletin has attained more and more international recognition, not to mention the citation of publications in previous volumes, as can be seen from the contributions of 17 research papers by international students of the M.Sc. program. This program is an intensive one year curriculum that has been taught in the Geology Department of CU in the academic year 2009/2010 for the first year. These scientific papers were extracted from the students' independent studies which are compulsory for each individual student in the program. Because of the confidentiality reason of a number of contributions, the requirement of the Chulalongkorn Graduate School as well as time constraints of the program, only short scientific articles were able to release publicly and publish in this Bulletin.

Lastly, on behalf of the Department of Geology, CU, I would like to acknowledge the Department of Mineral Fuels, Ministry of Energy, Chevron Thailand Exploration and Production, Ltd, and the PTT Exploration and Production Public Co., Ltd., for providing full support for the Petroleum Geoscience Program and the publication cost of this issue. Sincere appreciation also goes to guest editors; Professors Joseph J. Lambiase, Ph.D., John K. Warren, Ph.D., and Philip Rowell, Ph.D., the full-time expat staff, for their contributions in editing all those papers. Deeply thanks also go to Associate Professor Montri Choowong, Ph.D., the current editor-in-chief, and the editorial board members of the BEST who complete this issue in a very short time. The administrative works contributed by Ms. Suphannee Vachirathienchai, Ms. Anamika Junsom and Mr. Thossaphol Ditsomboon are also acknowledged.

Associate Professor Visut Pisutha-Arnond, Ph.D.
Head of the Geology Department
August 2010

Building a Core-calibrated Wireline-based Permeability Prediction Model for Ubon Field, Thailand, with Model Testing in Uncored Well Sections and Validation by TST or DST

Prateep Chaiwan*

Petroleum Geoscience Program, Department of Geology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

*Author email: prateepc@chevron.com

Abstract

In this study, the goal is to create a permeability prediction model for the UB01 and UB02 wells in UBON field. Based on a re-evaluation of existing core characteristics and the multivariate validation of wireline values using core-measured rock properties in these wells, the following input parameters were tested; depositional environment, provenance, compaction and diagenesis. Depositional environment was found not to be significant as an input parameter to the permeability model based on data from the two wells; the rest of parameters were, except that provenance, although statistically classified as significant, exerts a minor influence compared to the others. A permeability prediction model was generated by multiple-linear regression based on the statistically-significant relationships that have integrated core-plug permeability measurements and wireline log responses. However, only UB02 well parameters were used to create the prediction model, as this well showed suitably high regression coefficient values when relating wireline values to compaction (represented by depth in TVDSS) and diagenesis (represented by clay content). A UB01 well permeability prediction model was not built as any integration of all tested parameters showed poor correlation coefficient values. Well test validation was used to independently test and confirm that a core-plug based permeability prediction model can be representative of whole-sand-body flow capacities in potential reservoir intervals, both within and outside of the zone where it was constructed.

Keywords: Permeability, Drill Stem Test

1. Introduction

1.1 Geology of Ubon field

The Ubon area is located in the eastern portion of Block B12/27 which is located in the Southern Pattani Trough (N-S trending basin)/ Northwest Malay Basin the Gulf of Thailand. The Ubon Field is in the Ubon trend, one of the six Miocene structures within the block (Figure 1).

The Ubon structural trend is located in an inter-basinal setting between the northern Malay and southern Pattani Basins. The trend consists of a complex series of offsetting faults in the Miocene section, which develop a series of relatively small, discontinuous grabens and horsts with tilted fault-blocks trending in a dominantly north-south direction. This structural graben trend lies updip and to the east of an older half-graben sub-basin. The older half-graben contains Sequence 1 sediments and has an active petroleum system with apparently distinctive characteristics (Oliva, 1996). Geochemical data suggests that organic-rich lacustrine rocks of Oligocene (?) Sequence 1 and Early Miocene lower Sequence 2 were the source to the variable, waxy crude oils found in that area. Hydrocarbons are trapped in tilted fault blocks against trapping faults with associated three-way structural closures.

1.2 Aims and Objectives

The aim of this study is to produce a rock-property model for variations in porosity and permeability, tied to the existing depositional understanding of the area, relate it to well tests and so improve our ability to understand and predict permeability in the Ubon area. Two objectives were designed to achieve this aim.

The first objective of this study is to identify wireline-defineable relationships with rock properties, validated by ties to plug-derived rock properties in wells Ubon 1 and Ubon 2. The second objective is to create a permeability prediction model based on the Ubon dataset, focusing initially on the Ubon-01 and Ubon-02 wells.

2. Database

Four types of data were used to this study including; UB01 and UB02 Core analysis data (Core plug, thin section, XRD & SEM/EDS, and core spectral gamma), 187 relative permeability points in both wells from Probe permeametry, full quart combo wireline logs sets for both wells, and 2 drill stem tests (DSTs).

3. Methodology

In order to define depositional environment; core logs, core photos and direct observations are tied to wireline outputs. For diagenesis, which it is strongly related to provenance in the study region: thin section petrography is utilized and the resulting mineral framework (QFL) is also used to predict the provenance. As wireline logs responses are an indirect measurement, a correlation can sometimes made to direct or primary interpretation data, such as depositional setting and provenance. Wireline logs are also used to predict reservoir quality, in this case they are tied to plug-based porosity and permeability measurements. However, the geological heterogeneities that characterize rock properties in the subsurface means that core plug values as measures of reservoir quality need to be addressed by considering how well these point measurements can represent whole sand body. This will be done using the well tests as validation of core plugged indications of reservoir quality, that is, do the intervals flow

4. Results

4.1 Permeability prediction model

The derived permeability prediction model, based on wireline logs, is in good agreement with measurements in the UB02 well, with a correlation coefficient 0.88 (Picture 2 (A)). But a permeability prediction model is not easily generated for well UB01 because of poor correlations between poroperm and wireline log values.

To test the validity of the permeability controlling parameters identified in this study, two non-linear and nonparametric neural network paradigms, namely Back Propagation Neural Networks (BPNN) and Artificial Neural Networks (ANN) were used, based on the parameters found to be significant in this study (in UB02). Neural network processing was run to output a core-plug based permeability curve for UB02. The wireline parameters used as inputs were; gamma ray, potassium, thorium, uranium, density, neutron, sonic and depth in TVDSS. One hidden layer, with 5 neurons, is processed in ANN training. The correlative coefficient between BPNN predicted permeability and core plugged permeability is 0.9735, figure2 (B).

4.2 Well test validation

Well test validation is used to quantify the performance of a reservoir at the fieldwide scale, while core plug-based models test the reservoir quality at the interwell scale. In this study, a well test validated by core plug data, is available within the well, UB02 core#2 sandstone at 8124.5 ft -8148.5 ft wireline depth in MD, using UB02 drill stem test (DST) # 4. Based on the work in this present study, this cored sandstone interval samples a high permeability zone (average 118 md). The general result indicates a good tie with the DST result, which concluded it was run over a zone of high fluid flow

To further refine these results, I applied the permeability prediction model, based on the UB02 cored interval, to the well UB01 across an interval which also had a DST test result but was over an uncored zone in the well. The result was a matched trend as both the permeability output and the high flow rate in the UB01 DST#1 test result indicated a zone of good permeability over this interval

5. Conclusion

The derived Permeability prediction model is not necessarily a function of depositional environments but of rock properties, which can be related to depositional setting or diagenetic overprint.

Provenance exerts minor effects on permeability distribution in sands with similar depositional settings, but is not a variable used in constructing the permeability prediction model, as it has limited expression in conventional wireline log values in the studied intervals.

Compaction and clay content, as related to depth, are functions in the permeability prediction model, and indicated in crossplots of conventional log values, which are predictive for the UB02 well. While in the UB01 well there was no obvious crossplot trend.

Total gamma ray, potassium, thorium and uranium, are useful to in recognizing variations in the clay content, and also relate to depth in TVDSS. As such, they are helpful in quantifying the compaction effect in UB02 well. No conventional wireline log combination was identified in the UB01 well that can be used to recognize the clay content and compaction trend.

Conventional wireline logs, including of potassium, thorium, uranium, sonic and density, and depth TVDSS, via principal component analysis) are useful in generating a permeability prediction model for the UB02 well. But the same techniques are not valid in the UB01 well, as permeability trends cannot be defined from its wireline suite. Therefore, a fluvial deposit based model (using UB02 sandstones) generates a predictable permeability model, while at this stage an alluvial wet fan deposit based model (UB01 sandstones) does not and requires further study.

Well test validation (Drill stem test or DST) is helpful in confirming whether the core-plugged based permeability prediction model can be representative of whole sand body flow capacity.

This result validates the application of a core-plug calibrated permeability prediction model in uncored intervals in wells with similar depositional settings and diagenetic histories.

6. Acknowledgements

I would like to thank to Chevron Thailand E&P for permission to use the data, including core, wireline logs and well tests and their financial support throughout the course.

7. References

Mountford, N., 1992. A Review of Hydrocarbon Potential & Future Exploration Strategy, Block B12/27: Unocal Thailand, Exploration New Ventures, v.1, 51 p.

Oliva, L., 1996. Block B12/27 Greater Ubon trend, Ubon Field, Guilf of Thailand: Unocal internal Report.

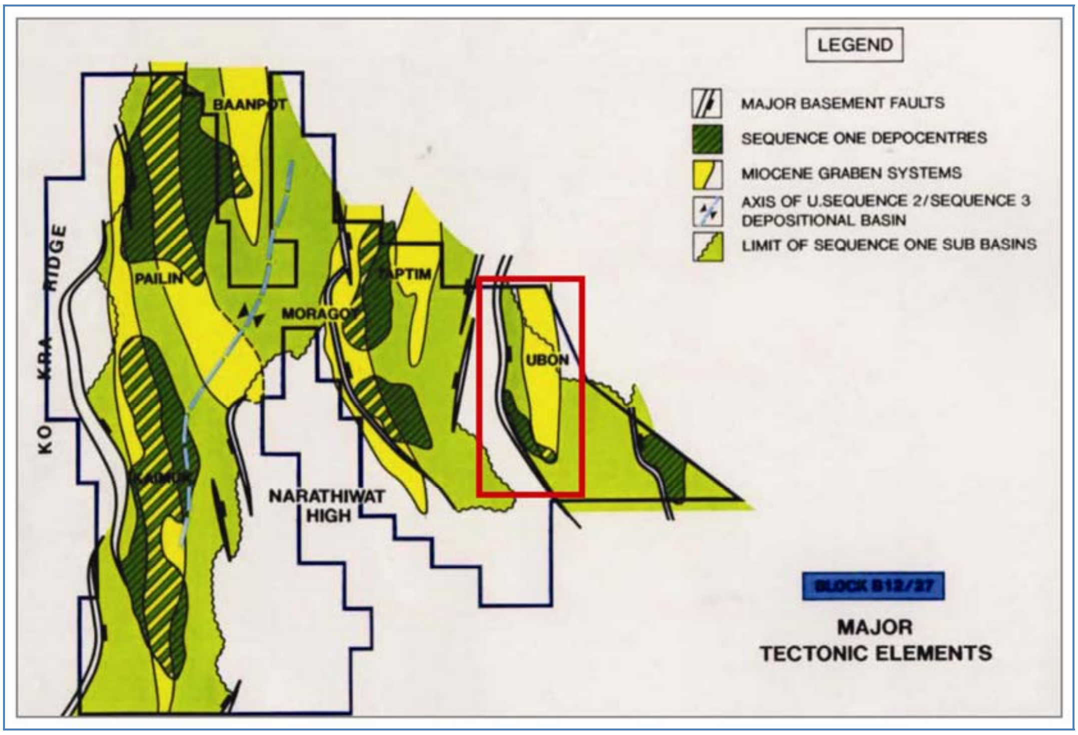


Figure 1. shows structure of Ubon trend showing the shift of N-S trend in Pattani trough to NW-SE trend in Malay Basin (modified from Mountford, 1992).

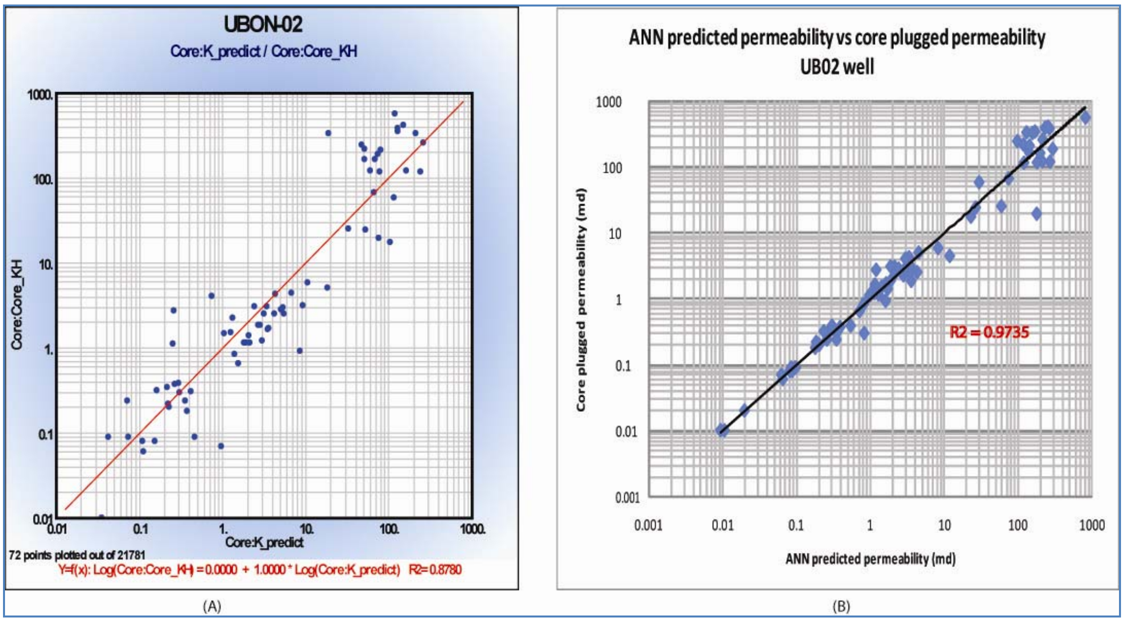


Figure 2. (A) Cross plot of core plugged permeability and permeability predicted from wireline logs multiple linear regression, (B) from ANN predicted in UB02 well.