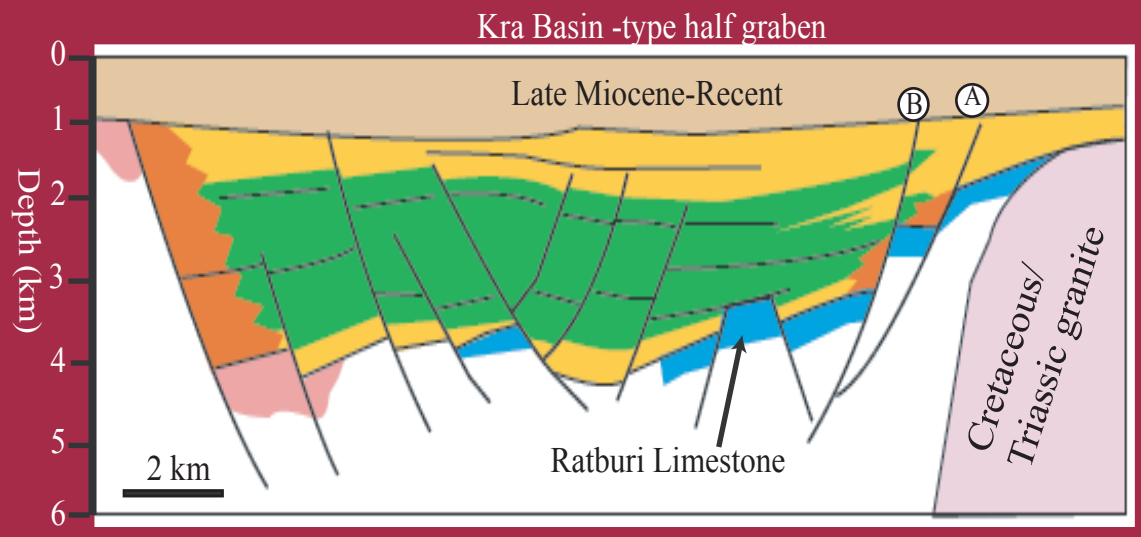
Bulletin of Earth Sciences of Thailand (BEST)

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

Bulletin of Earth Sciences of Thailand

Hydrocarbon Distribution in the North Jakrawan Field, Pattani Basin, Gulf of Thailand

Kriangkrai Kantatong*

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

*Author email: kkjc@chevron.com

Abstract

Seismic data, wireline logs and geochemical analysis were integrated in an attempt to understand the petroleum system in the North Jakrawan field where gas pay distribution varies widely across the field. The objective was to investigate the factors that control hydrocarbon distribution across the field, in particular, why is there significantly more pay on one side of the field compared to the other. Structural maps of the MMU, C and K marker levels suggest that the North Jakrawan field is entirely influenced by north-south trending normal faults. East dipping synthetic faults conjugated by west dipping antithetic faults control the half graben geometry of the field. Isochron maps of sequence 3 (source rock and reservoir intervals) and 4 (reservoir intervals) also indicate that the formations thicken westward. Hydrocarbon generation windows suggest that gas-prone source rock (sequence 3) is currently mature on the eastern flank of the field while the western flank is overmature. Migrations are typically from west to east. The average net-to-gross calculated within each fault block indicates that there are more potential sand reservoirs toward the eastern flank. Clay smear calculation techniques confirm that sealing capacity of fault planes is typically effective. Analysis of the various components of the petroleum system in the study area suggests that hydrocarbon distribution is mostly controlled by migration effectiveness and structural closure. The western portion of the North Jakrawan field has a more effective petroleum system than the eastern portion, especially the downthrown block of fault A, where structural closure focuses hydrocarbon into an accumulation.

Keywords: Hydrocarbon distribution, Jakrawan, Pattani Basin

1. Introduction

Petroleum system elements (source rock, reservoir, seal and trap) can change rapidly and to understand some of their variations the North Jakrawan field (Figure 1) was selected to be studied. Within this field the pay distribution varies widely. . The objective of this study was to investigate the factors that control hydrocarbon distribution across the North Jakrawan field, and in particular, why is there significantly more pay on one side of the field compared to the other.

2. Methods

Wireline data are used to evaluate reservoir potential. Net-to-gross maps were generated from the existing wells. Gamma ray, resistivity, neutron and density logs were used for lithology correlation.

Sealing potential was evaluated by using lithological information from wells to determine the sealing ability for each fault block using clay smear techniques.

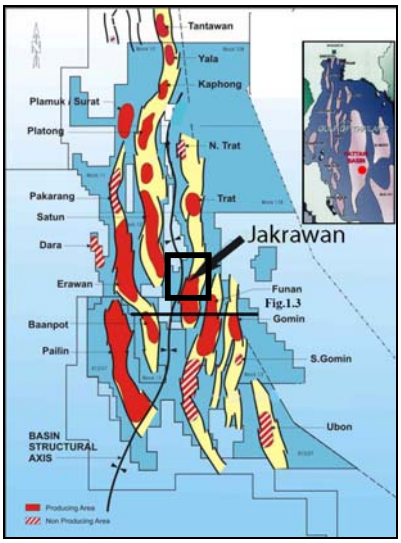


Figure 1. Location map of the fields in the Pattani Basin in Gulf of Thailand. Jakrawan field is located in the middle portion of the Pattani basin.

Seismic data provided structural style information. Structural style is important to understand the controlling factors of petroleum systems. Well to seismic ties are necessary to relate depth to time.

Source rock potential was assessed and integrated into the study using geochemical and migration analysis and by constructing isopach maps. Vitrinite reflectance data were used to evaluate hydrocarbon generation windows in the area.

3. Results

3.1 Seismic interpretation

The syn- and post-rift section of the North Jakrawan field is affected by numerous normal faults (Figure 2).

Major synthetic faults dip structurally in east direction. Numerous antithetic faults are mainly conjugated on east dipping faults. East dipping synthetic faults are dominant in the North Jakrawan field. Isochron maps of sequences 3 and 4 show that the North Jakrawan area is located on the basin flank where the formations thicken westward. The main depocenter in this area is located to the west of North Jakrawan field.

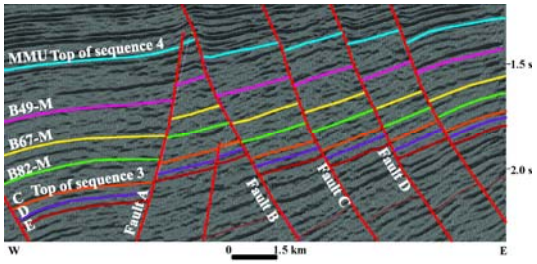


Figure 2. A cross section showing six key stratigraphic intervals which were evaluated for gross sand and net-to-gross distribution.

In general, hydrocarbons migrate from west to east (Figure 3). Sequence 3, the main gas-prone source rock in the Pattani basin (Jardine, 1997), is mainly overmature. Relatively small parts of sequence 3 in the east flank are currently mature. Sequence 1 is in the overmature window across this area.

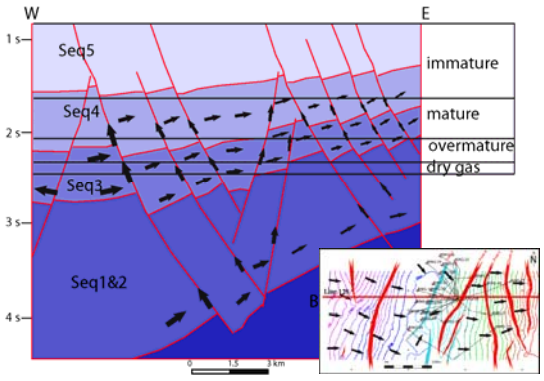


Figure 3. A cross section of line 128 overlain by migration pathways. Size of arrow indicates quantity of hydrocarbon with respect to source rock thickness, migration effectiveness and maturation window.

3.2 Well log analysis

Average net-to-gross maps for all intervals show that the net-to-gross percentage in general increases from west to east. Overall, sand percentage decreases from top to bottom of the six key stratigraphic

intervals (Figure 2). All well groups show clearly that sequence 4 is sandier than sequence 3.

Clay smear parameter calculation techniques show that the SSF is always less than 7 and the SGR is more than 20% for all faults at all levels. These values suggest that all faults are effective seals.

4. Discussions

Firstly, gas-prone source rocks are overmature on the western flank of the study area while the eastern flank is currently mature. Migration is in west to east direction. Cross fault migration results in less migration efficiency in an eastward direction. Consequently, the eastern fault blocks are likely to have less hydrocarbon potentially available to be trapped. Structural closure on downthrown side of fault A at 'C marker' level (Figure 2) can focus hydrocarbons into accumulation while other fault blocks are dominated by ramping structure where the hydrocarbons are likely to migrate to updip positions.

Secondly, the average net-to-gross calculated within each fault block indicates that there are more sands toward the eastern flank. This may be because the eastern flank is located closer to the basin margin where the sediment provenance is located.

Thirdly, it can be seen that not all pay zones can count on shale juxtaposition to seal. However, non-shale juxtaposition seals can be explained by clay smear parameters. The four faults (A, B, C and D) are shown to be effective in clay smear sealing by having SSF and SGR factors exceeding the threshold requirement for sealing (Gibson, 1994; Yielding *et al*, 1997) at all potential reservoir levels.

5. Conclusion

The petroleum system in the North Jakrawan trend is summarized as follows:

1. Structural style is dominated by north-south trending normal faults.
2. Migration pathways are generally from west to east direction. Cross-fault migration is achieved through sand to sand juxtaposition. Gas-prone source rock (sequence 3) is overmature in western portion while eastern flank is currently mature. Overall, high potential in generating hydrocarbon is located in the western portion as post-rift section (sequence 3 and 4) thickens westward.
3. Sand-prone facies percentage increases towards east where sediment provenance is located.
4. Sealing capacity of fault planes is typically effective.
5. There are two types of fault trap in the study area. Upthrown side of Fault B, C and D and downthrown traps associated with fault A.

Analysis of the various components of the petroleum system in the study area suggests that hydrocarbon distribution is mostly controlled by migration effectiveness and structural closure. The western portion is better than the eastern portion of the North Jakrawan field, especially the downthrown block of fault A where structural closure focuses hydrocarbons into an accumulation.

6. Acknowledgements

I would like to express my sincere gratitude to Chevron Thailand Exploration and Production (CTEP) for offering me the opportunity to pursue this M.Sc. Petroleum Geoscience degree. The geochemistry analysis, well logs and seismic data used for this research were provided by CTEP. Many thanks to all the CTEP staff who have provided valuable support. The project supervision by Professor Dr. Philip Rowell is much appreciated.

7. References

Gibson, R. G., 1994. Fault-zone seals in siliciclastic strata of the Columbus Basin, offshore Trinidad: *AAPG Bulletin*, v. 78, p. 1372–1385.

Jardine, E., 1997. Dual petroleum systems governing the prolific Pattani Basin, offshore Thailand: *Proceedings of the Petroleum Systems of Southeast Asia and Australasia Conference*, May 21–23, 1997: The Indonesian Petroleum Association, p. 351–363.

Yielding, G., Freeman, B. and Needham, D. T., 1997. Quantitative fault seal prediction: *AAPG Bulletin*, v. 81, p. 897–917.