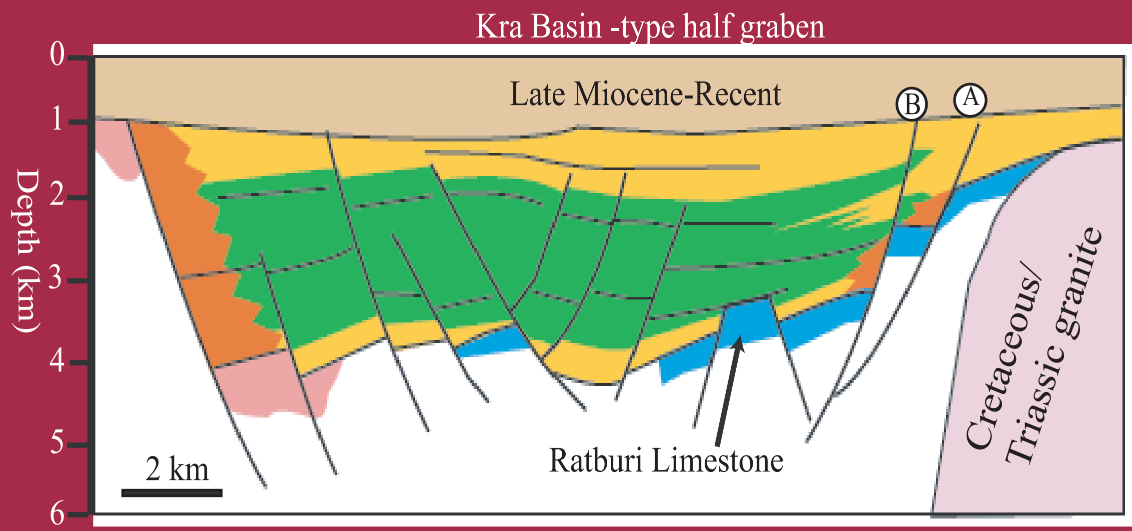
Bulletin of Earth Sciences of Thailand (BEST)

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)

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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.
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August 2010

Trap Mechanism in the Southern Kra Basin, Gulf of Thailand

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Abstract

This study will identify potential traps in the southern Kra Basin large structural closures and seismic geometries, and evaluate seal capacity by using fault character, fault throw and sand thickness cross plots. The main trap styles are northeast-southwest trending listric normal faults that extend into the post-rift reservoir as a product of basin subsidence. Faults usually trap hydrocarbons on their up-thrown sides. Reservoir successions from adjacent basins indicate a thickness range from thin sand (0.3m) to thick sand (73m), while fault throw varies from 30 m to 305 m. Fault throw and reservoir sand thickness cross plots indicate high fault seal probability, which suggests most fault throws completely offset reservoir sands, so the faults are sealing. Seismic character indicates lateral lithology changes from sand-rich successions on the basin flank to basinal shale-rich successions, with low to moderate amplitude and continuity on the flanks of the basin and moderate to high amplitude and continuity basinward. Fault traps have a high probability for trapping and sealing basinward, where there is thick shale and large fault throws. Traps on the basin edge have low potential because the area is sand-rich with small fault throws.

Keywords: Trap mechanism, Kra Basin, Potential trap, Fault trap

1. Introduction

The southern Kra Basin lies to the west of the Pattani Basin and is separated from it by the Ko Kra Ridge (Crossley, 1990; Jardine, 1997; Figure 1). The study area is approximately 34 km long and 13.6 km wide. Trap is a high-risk element and the main potential exploration problem because other elements are proven in the area. Traps may not be thick with high percentages of shale and fault throws may not be enough to trap significant hydrocarbon volumes. Lithology and seismic character in the southern Kra Basin is expected to be the same as in the Kra and/or Western Basin. Fault throw lengths and sand and shale thickness correlations is one way to investigate the trap problem in the exploration area.

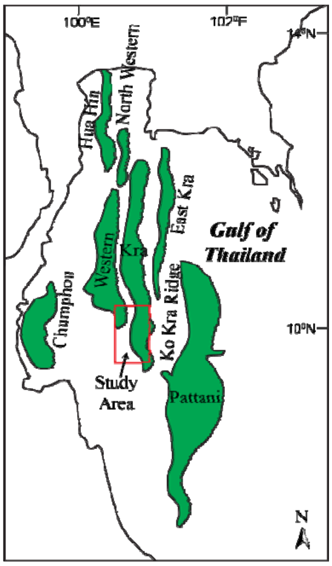

Figure 1. Regional basin map of the southern Kra Basin (red block), modified after Pigott and Sattayarak (1993).

The aim is to evaluate seal capacity by using 3D-seismic data to identify fault character, fault throw and sand thickness cross plots, structural mapping and trap mechanism. This study will identify potential traps with large structural closures and seismic geometries.

2. Methodology

Lithologic interpretation from wells 7- 103-1x, B7/32-1 and B7/32-2 focuses on sand and shale thickness in the reservoir succession (S3) and source rock unit (S2) and ties log character to seismic character by synthetic seismogram. Seismic character indicates lithology. Fault throws were measured on S3 and cross plotted with sand thickness. This relationship was integrated with the structural map and seismic character to identify potential traps.

3. Results and Discussion

The potential traps in the southern Kra Basin are located on the up-thrown side of faults and some fold-associated faults. The traps are created by large fault throws and high shale percentages; a configuration that is more abundant down-dip in this asymmetrical basin. Fault geometries in the southern Kra Basin are generated by extension and basin subsidence controls fault displacement, which generally increases down-dip. Fault displacements are low on the edge of the basin but large in the basin. Fault throw is greater than 30 m and increases with depth to nearly 305 m at TS2, which is much larger than the reservoir sand thickness (Figure 2). Well log data indicates sands range from very thin (0.3 m) to thick (73 m), although almost are thin. At well 7-103-1x, seismic amplitudes are low to moderate, with some moderate to good traps in the southern Kra basin corresponding to amplitude events toward the east that accompany an abrupt change from sand to shale on gamma ray logs (Figure 3). The amplitude reflection character is low to moderate on the flank of the basin and moderate to high in the basin and the

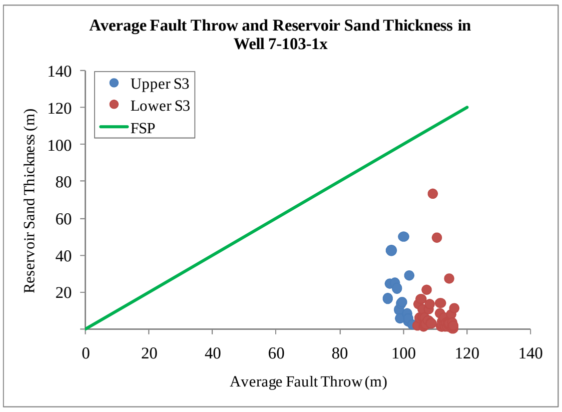

Figure 2. Cross plots of average fault throw and sand thickness in well 7-103-1x.

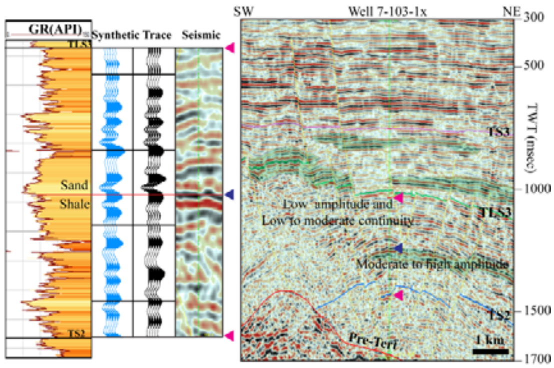

Figure 3. Lithology response to seismic reflection from well 7-103-1x in the Kra basin.

continuity of seismic reflections is higher down-dip (Figure 4a) Seismic character indicates a corresponding lateral variation in lithology from a sand-rich succession on the basin flank to a shale-rich succession basinward (Figure 4b).

The structural and stratigraphic trends occur down-dip from the basin flank are similar in other half-graben rift basins. The structural evolution of wedge-shaped basins ensures that the largest fault throws are in the down-dip areas where they have a high probability of sealing by offsetting reservoir sands or clay smear. The structural style also causes longer faults with wider fault planes down-dip, which increases the number and size of potential traps basinward.

The tectonic and stratigraphic evolution of a half-graben rift basin should generate a lithologic distribution with a high sand percentage succession on the basin flank and a shale-rich unit within the wedge-shaped geometry of the sedimentary succession.

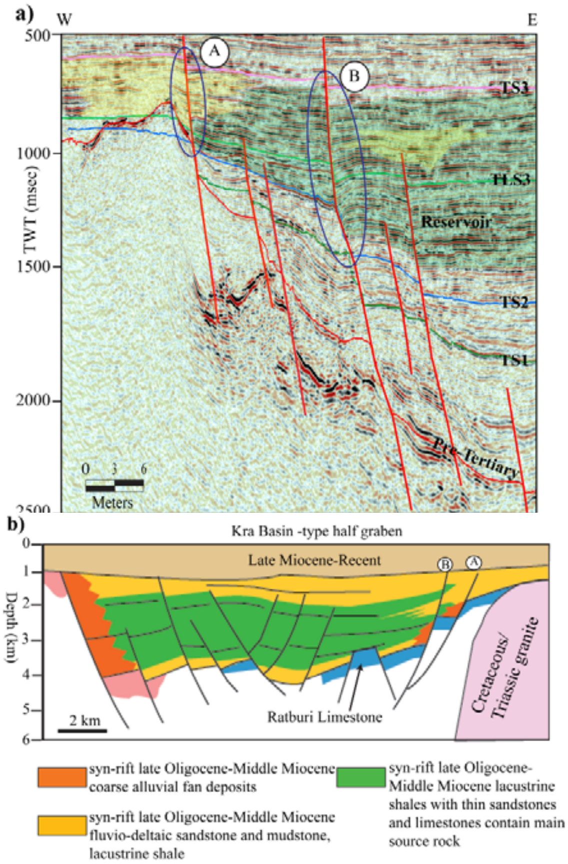

Figure 4. The character of fault traps (a) Seismic geometries on the main fault traps (b) A schematic model of the Kra basin (modified from Morley and Westaway, 2006)

4. Conclusion

An investigation of trap potential in the southern Kra Basin based on fault throw and sand thickness determined that:

1. The significant traps are listric normal faults trending NW-SE that are caused by basin subsidence and pre-existing faults that extend into the reservoir section in the post-rift phase.

2. Fault displacements are low on the edge of the basin but faults in the basin have high fault throws that range from approximately 30 m at TS3 and increase with depth to nearly 305 m at TS2. Sand thickness from well log data indicates sand ranges from a few centimeters (0.3 m) to 73 m thick. Cross plots correlating fault throw to sand thickness indicate that where fault throw offsets reservoir sands that fault is sealing.

3. Seismic character indicates a lateral lithology distribution from sand-rich successions on the basin flank to shale-rich successions basinward, and seismic reflections have low to moderate amplitude and continuity on the basin flank and moderate to high amplitude and continuity in the basin.

4. Trap potential in the southern Kra Basin is higher basinward than on the edge of the basin. Traps in the basin have high shale percentages and large fault throws.

5. In a half-graben, trap potential generally increases down-dip from the flank of basin because fault throw and shale percentage increases basinward.

5. Acknowledgements

The author would like to thank Chevron Thailand Exploration and Production for the opportunity to enroll in the M.Sc. program, the Exploration and New Venture Team provided all seismic and well data. Professors Joseph Lambiase and Philip Rowell are thanked for teaching, discussion and suggestions. The Faculty of Science, Chulalongkorn University and Petroleum Geoscience Program for rooms and equipment. Thanks to Carole Schaefer and Dieter Letch for suggestions and data coordination.

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