Bulletin of Earth Sciences of Thailand

Depositional Environment of the Basal Pratu Tao Formation Thap Raet Field, Phitsanulok Basin, Thailand

Phalaphoom Thamniyom

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

*Corresponding author email: phalaphoomt@gmail.com

Abstract

This study was conducted to better understand the depositional environment of the Basal Pratu Tao Formation in the Thap Raet Field, Phitsanulok Basin in order to improve the prediction of reservoir distribution and properties. Two conventional cores and 11 well logs were integrated were used to interpret the depositional environment and establish paleogeographic models of the third order event. The depositional environment of the Basal Pratu Tao Formation was identified as a river-dominated lake delta consisting of: 1) a delta front to pro-delta, 2) a delta plain environment, and 3) a delta plain to proximal delta front facies. In addition, this study interprets the rivers in the lake delta system as distributaries of one river as opposed to multiple rivers. It also indicates that the delta had a NE-SW orientation, with distributaries coming in from the north and northwest. Stacked channels and mouth bar sands are good reservoirs in the field and apparently extend across the study area. Consequently, there is no concern about reservoir distribution for field development.

Keywords: Sirikit Field, River-dominated Lake Delta, Distributary Channel

1. Introduction

Thap Raet Field, which is located in the northern part of the Sirikit Field, Phitsanulok Basin (Figure 1) is being in the second phase of field development. Water injection wells and in-fill wells are required to increase the production rate of the field. The objective of this study is to improve the understanding of depositional environments in order to enhance a prediction of reservoirs distribution and properties. This study scope on the integrating well logs and cores together to interpret the depositional environments and establish the paleogeographic models on the third order event. Two conventional cores and 11 well logs were used were integrated in order to meet the objective (Figure 2). This study focused on the Basal Pratu Tao Formation, which is the main reservoir in the field.

2. Regional Geology of Phitsanulok Basin

The Phitsanulok Basin is located in the lower northern region Thailand. It was formed as a result of a relative movement between Shan Thai and Indochina craton. The basin was controlled by four major fault systems, consisting: 1) Uttaradit fault to the north, 2) Phetchabun fault to the east, 3) Mea Ping fault to the south, and 4) Western boundary fault to the west. Normal faulting of the western boundary fault system controlled the basin into half-graben basin.

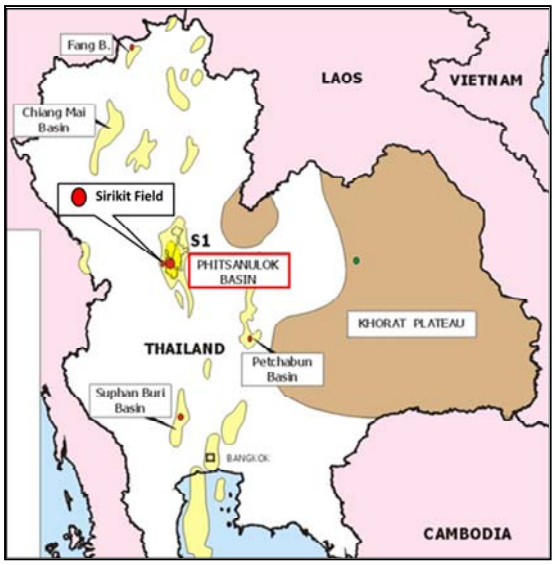

Figure 1. Location of the Sirikit Field.

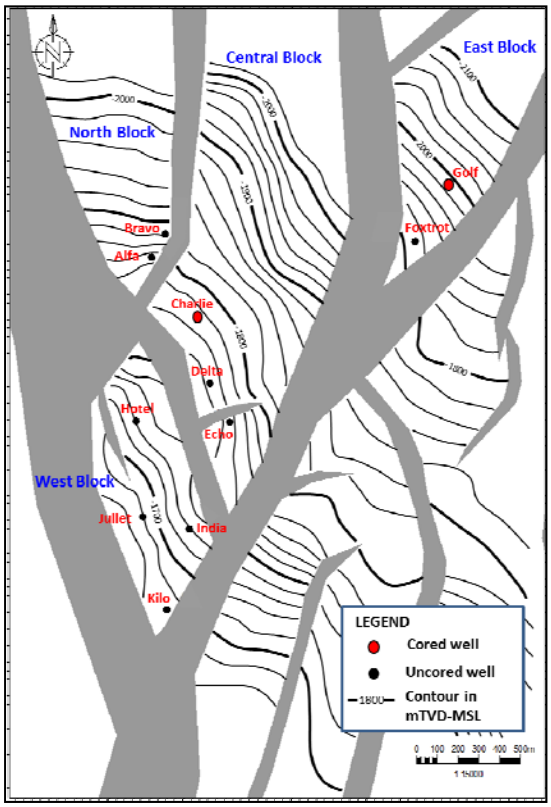

Figure 2. Thap Reat Field structural map demonstrates that the field was divided into four blocks, and also shows the well location.

The stratigraphic sequence of the Phitsanulok Basin consists of seven formations, including: 1) a proto-lake and floodplain sediments of Nong Bua Formation, 2) an alluvial fan and a delta fan sediments of Sarabop Formation, 3) a lacustrine shale of Chum Saeng Formation, 4) a fluvio-deltaic of LanKrabu Formation, 5) a fluvial-dominated delta sediments of Pratu Tao Formation, 6) a fluvial sediments of Yom Formation, and 7) an alluvial fan sediments of Ping Formation. Lan Krabu and Pratu Tao Formation are main reservoirs in the basin whist Chum Saeng Formation is a source rock and seal.

3. Core interpretation

Two conventional cores were logged at the 0.5 m scale by recording grain size, sedimentary structures and trace fossils.

Five lithofacies were identified and interpreted the depositional environment, consisting: 1) *claystone with roots and bioturbation facies* which is interpreted as a fluvial floodplain, 2) *cross-laminated muddy siltstone facies* which is interpreted as a levee deposit, 3) *silty sandstone facies* which is also interpreted as a levee, 4*) cross-laminated, fining-upward sandstone with gravel lags interbedded and basal sandy conglomerate* (Figure 3 and 4) which is interpreted as a fluvial channel that is not far from the lake shoreline as a present of mud drape on wavy sand feature, and 5) *coarsening-upward sandstone* that indicates to a bar-head part of a fluvial point bar (Bridge, 2006).

Core stratigraphy in the both cores demonstrates a fluvial succession, where as a channel point bar follows by overlying floodplain. However, the thickness a single channel in the Charlie well is slightly thicker than the Golf well.

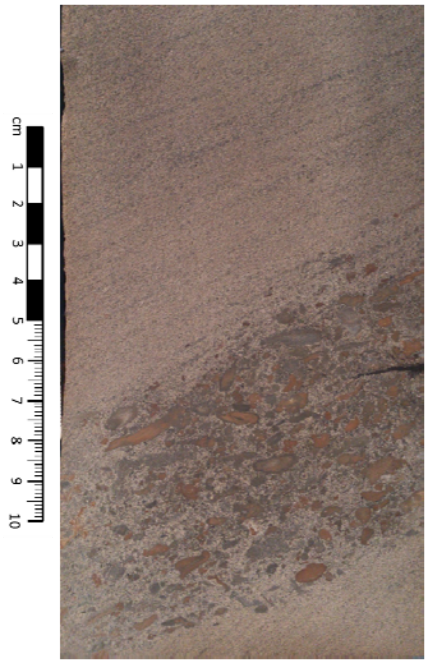

Figure 3. Gravel lags interbedded in *a cross-laminated, fining-upward sandstone facies*.

Figure 4. Erosive contact between conglomerate base in *cross-laminated, fining-upward sandstone facies* and *claystone facies*.

4. Well log interpretation

11 well logs were interpreted based on core information, and correlated well to well across the area.

First of all, core stratigraphy was correlated to the well log in order to recognize a gamma ray log pattern. A blocky shape following by bell shape of low gamma corresponds to fluvial point bar sand whist a funnel shape corresponds to a bar head sand. A high gamma ray corresponds to a floodplain claystone whereas low spike of gamma corresponds to a conglomerate or gravel lag. Nevertheless, conglomerate and gravel lag are not always recorded as a low spike of gamma ray. Abruptly change from high up to low gamma indicates an erosive contact between claystone and conglomerate.

The whole section of the Basal Pratu Tao Formation in well log was interpreted

based on above information. However, the zone without core information was interpreted using log character only. The depositional environment in Basal Pratu Tao Formation was identified into three environments, consisting: 1) Delta front to Pro-delta where comprise mouth bar sand and mud, 2) Delta plain where comprise a stacked channel sands and floodplain mud, and 3) Delta plain to Proximal delta front facies where comprise channel and mouth bar sand (Figure 5). Three paleogeographic maps were established from those environments. It demonstrates that a delta has N-S orientation whereas a distributaries of one river coming in from the north and northwest (Figure 6).

5. Depositional History

The depositional history of the Basal Pratu Tao Formation in the Thap Raet Field was divided into three stages based on core and well log interpretation.

The Basal Pratu Tao formation was deposited following Chum Saeng Formation, which accumulated when lake level was highest and the flooded area covered the study area and Phitsanulok basin. The Basal Pratu Tao Formation started depositing a prograding delta into the lake during a water level still stand or commenced decreasing. Mouth bar sands were deposited on the delta front whilst mud were accumulated in pro-delta. The environment changed from delta front to delta plain as progradation continued. Stacked channels were deposited on a delta plain that was not far from the lake shoreline. The study area is in one lake delta system with multiple distributary channels flowing into the lake. These channels were controlled by fault, especially in the east block of the field. The last stage of Basal Pratu Tao deposition occurred when lake level began to rise again and the depositional environment was in transition between delta plain and proximal delta front.

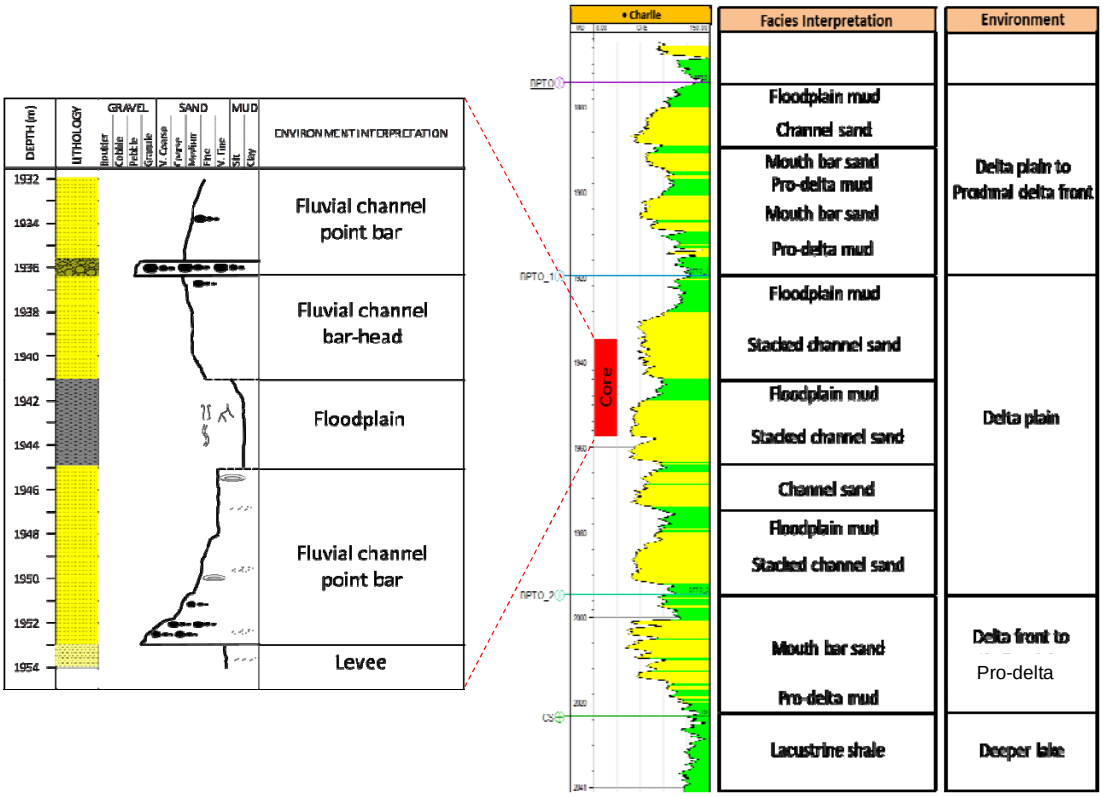

Figure 5. Interpreting depositional environment by integrating core and well log demonstrates that environment in the Basal Pratu Tao Formation can be divided into three environments.

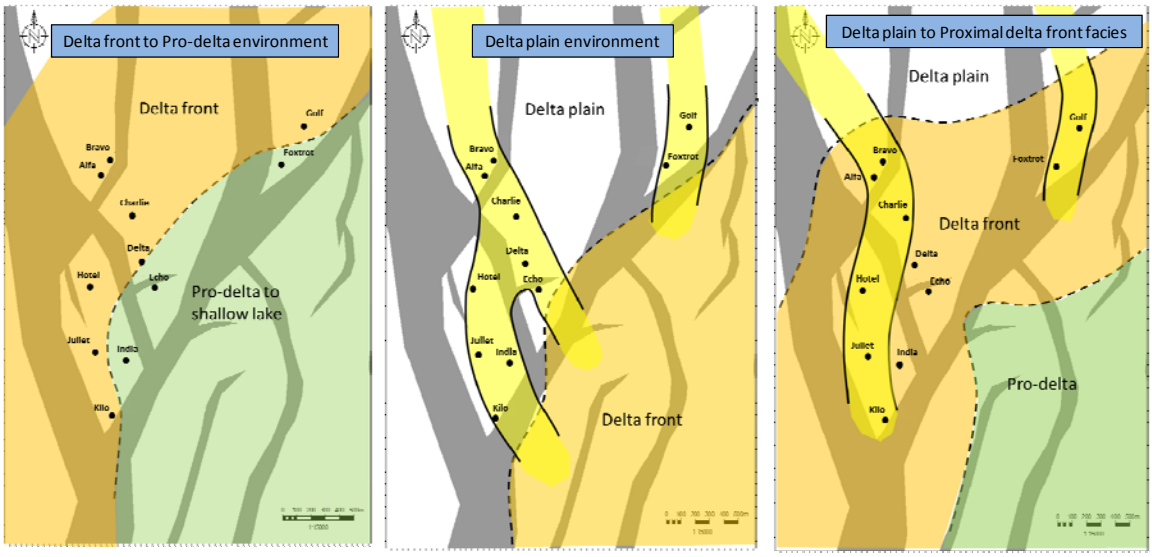

Figure 6. Paleogeographic maps of each depositional environments in the Basal Pratu Tao Formation.

6. Discussion

In this study, integrating well logs and core data enhanced the interpretation of depositional environment. Using only one set of data could lead to misinterpretation; for example, a stacked blocky pattern of gamma ray log might be interpreted as braided channels. Besides core information, an overall interpretation was changed to distributaries entering the lake.

With respect to the interpretation from integrating of cores and well logs, the overall depositional environment of the Basal Pratu Tao Formation is a river-dominated lake delta. The interpretation of this study is similar to a previous study of the Sirikit Field. However, this study interpreted the rivers in this lake delta system as distributaries of one river as opposed to multiple rivers. It also indicates that the delta has a NE-SW orientation, with distributaries coming in from the north and northwest. This information can enhance further field development and also nearby field studies.

The stacked channel sand is the best reservoir in the study area. It has high porosity and permeability, and also good connectivity. The sand reservoirs should occur throughout the field as it is present in every well across the study area. The mouth bar sand is a good reservoir as well as the channel sand. It may extend up to a few kilometers in one delta system. Therefore, the mouth bar has no problem for both vertical and lateral connectivity. Based on the distribution of stacked channel and mouth bar sands across the study area, there is no concern about reservoir distribution for field development.

7. Conclusions

1. This study identified the depositional environment of the Basal Pratu Tao Formation in the Thap Raet Field by integrating well logs and core data. The depositional environment is a river-dominated lake delta consisting of 1) delta front to pro-delta, 2) delta plain environment, and 3) delta plain to proximal delta front facies.

2. Reservoirs in the study area are stacked channel sands and mouth bar sands, which apparently extend across the area. Consequently, well to well correlation across the Thap Raet Field is not problematic.

3. Gamma ray pattern corresponds to lithology in the cored interval but it is not always reliable for interpreting depositional environment.

4. Integrating all data together enhanced the interpretation of depositional environment and can lead to improved field development.

8. Acknowledgements

First of all, I would like to thank PTTEP to support the scholarship for this program. I am very thankful to my supervisor, Prof. Joseph J. Lambiase for his support and suggestion. I am grateful to Supakorn Krisadasima to provide data and recommend on this research project. Finally, I offer my regards to all of those who support me during the completion of this project.

9. Reference

Bridge, S., 2006, Fluvial Facies Models: Recent Developments, Facies Models Revisited, SEPM Special Publication No.84, p. 85-170.