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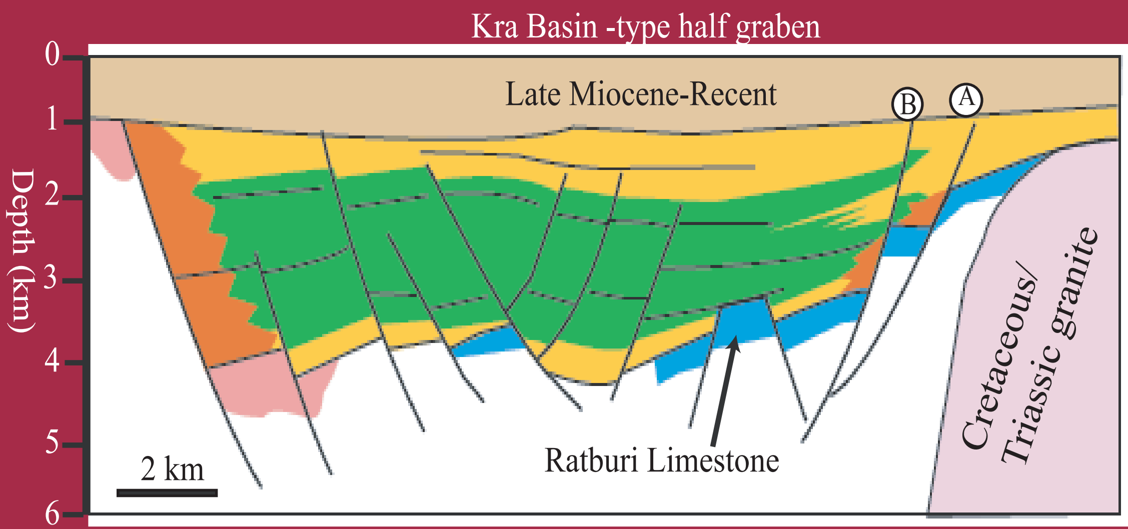

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Cover: A schematic model of the Kra Basin (page 3)

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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.

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An Overpressure Investigation by Sonic Log and Seismic Data in Moragot Field, Gulf of Thailand

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Abstract

The investigation of overpressure is important in the subsurface. In the Moragot field, southern part of the Gulf of Thailand, there are 4 wells where obvious overpressure was observed. Equivalent Depth Method and Eaton Method were used to compute pore pressure by using sonic log data in these 4 wells and the results were compared with the RFT log data. Dix's equation was used to convert the seismic post-stack velocities to interval velocities to examine the zone of overpressure. The computed overpressure by Eaton Method with exponential m factor equal to 2 gave the closest result to RFT data. In contrast, the seismic velocity data gave the poorer vertical resolution than sonic log data. Moreover, the seismic velocities were affected by the lithology changes in faulted areas so it was hard to identify the overpressure zone by seismic velocity. However, the deviation of sonic data and seismic velocity in the zone of overpressure do correspond and the overpressure zones in this study area are in the same stratigraphic level. At this level, the northwest part of Moragot field has higher pore pressure than the central part with no elevated pore pressure observed in the southeastern part. The structural map of top of overpressure shows that overpressure zones start at shallower depths in northwest Moragot field than other parts.

Keywords: Overpressure, Sonic log, Interval velocity

1. Introduction

The understanding of overpressure in the subsurface is important for drilling safety, exploration risk and reservoir depletion studies. In the Gulf of Thailand, there are some new areas that have high pressure and temperature; therefore, drilling programs in these areas have to be concerned. There are many ways to determine pore pressure using well data and seismic data. Each method is suitable for different geologic settings and causes of overpressure.

This research project focuses on the evaluation of overpressure and its distribution in the subsurface by using well sonic data and seismic data from the Moragot field in the Gulf of Thailand. Combining these data into a map of top overpressure may be useful for drilling program design not only for saving the cost but also for safety reasons.

2. Methods

The main objective of this study was to investigate overpressure by using well log data and to compare these results to seismic interval velocities. Sonic log data can be used to detect overpressure zones as sonic velocities decrease when pressure increases. When a sonic log encounters an overpressure zone, there is a noticeable deviation from the normal compaction trend. The magnitude of this deviation can be used to calculate pore pressure by using either the Equivalent Depth Method or the Eaton Method (Eaton, 1972; Kumar and Ferguson, 2006). In this study, computed pore pressures using these methods were compared with real pressure measurements from RFT data.

The first point of overpressure from RFT data and the first point at which the sonic log data breaks back from the normal trend were picked in the wells with known overpressure zones. These well picks were then tied to seismic using synthetic seismograms. A structural map of a horizon which tied the start of overpressure in the wells was created to represent the top of overpressure in the local area of the wells.

Post-stack velocity data was converted to interval velocities using Dix's equation (Dix, 1955). Interval velocities were overlain with seismic reflection data to observe the zones of overpressure and their relationship to interval velocities from the seismic (Mukerji *et al.*, 2002; Dvorkin and Walls, 2000).

3. Results

3.1 Sonic log data analysis

There are 12 delineation wells in the Moragot field but there are only 11 wells that collected RFT pressure data. From the RFT data, there are 7 wells that found elevated pore pressure and 4 in particular which have high pore pressure measurements; Moragot-01, Moragot-04, Moragot-05 and Moragot-08. All these overpressure wells show the deviation of sonic data from normal trend. Normal trend line of sonic log data was generated to calculate pore pressure by Equivalent Depth method and Eaton Method (Figure 1).

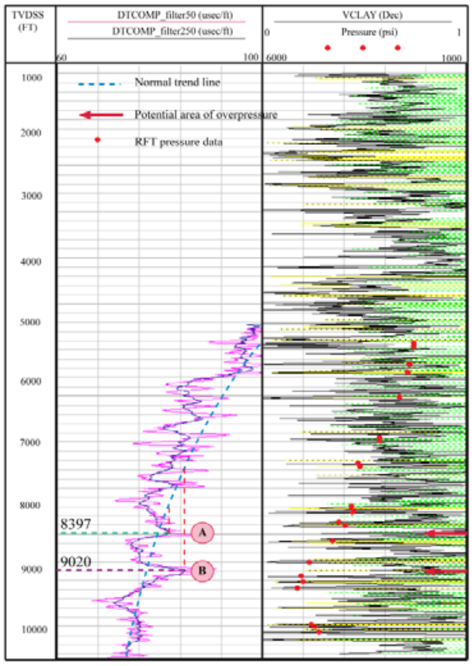

Figure 1. Overpressure calculation from sonic data by Equivalent Depth Method and Eaton Method in the Moragot-08 well. Red dots are RFT pressure measurements.

Pore pressure estimation from the Equivalent Depth and Eaton Methods were plotted to compare with the Repeated Formation Test data (RFT), the Lithostatic gradient and the Hydrostatic gradient (Figure 2). Overall, the Eaton method with m equal to 2 showed the best estimation than the others.

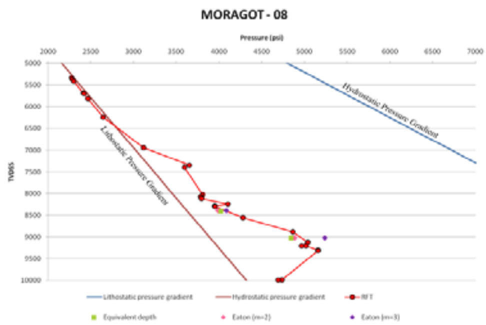

Figure 2. The relation between pore pressure and TVDSS in the Moragot-08 well by the Equivalent Depth, Eaton Method and RFT

3.2 Interval velocity model

Changes of interval velocity represent changes of lithology and also potentially zones of high pore pressure. To look for this, the calculated interval velocity was overlain on the seismic reflection data to observe the structure of formation and any correlation with the changes of interval velocity. In faulted areas, interval velocities show differences horizontally across the fault planes which may reflect the different lithologies across the fault cut (Figure 3).

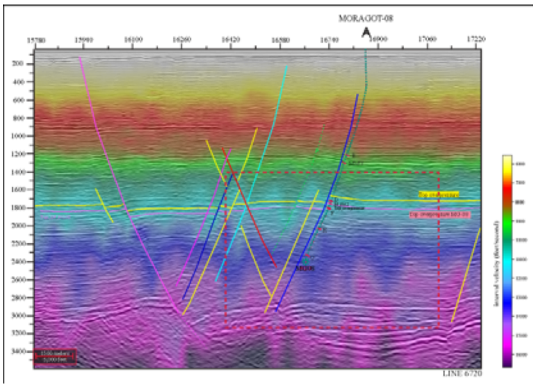

Figure 3. Seismic reflection data overlain by interval velocities along Line 6720, through Moragot-08 well.

The top of overpressure is quite flat and does not show any high amplitude (Figures 3). Also the relationship between top overpressure and the interval velocity distribution is not obvious as it difficult to define the top of overpressure by any consistent change of interval velocity. There are many other places along this seismic line that shows the difference in seismic interval velocity horizontally like at the Moragot-08 well. These low seismic velocity areas are possibly related to overpressure zones. However, this area was cut by a lot of major and minor faults which may affect the changes of velocity also.

4. Discussion

Sonic log data was used to calculate zones of overpressure and was shown that the computed pore pressure by the Equivalent Depth Method was a lot lower than the RFT data. However the Eaton Method gave a closer value to RFT data as long as the exponential m is suitable. The exponential m can be varied for each local area.

The top of overpressure in this study area was observed to be at the same approximate stratigraphic level, although it may be different in other areas.

The vertical resolution of seismic velocity information is lower than for well log data and it is more difficult to pick zones of overpressure using this data set. High vertical resolution seismic data should be used for pressure prediction as seismic data covers a wide area and could be very useful defining high pore pressure areas.

5. Conclusions

Overpressure in the Moragot field area occurs in the northwest side of the area. Sonic log data and seismic velocity data are useful tools for overpressure investigation. The deviation of sonic logs from the normal compaction trend is the implication for the identification of high pore pressure zones. Methods for pore pressure estimation can give the approximate value of pore pressure but not the exact number. The most suitable method for overpressure estimation is using well sonic data. RFT data is the measure of pore pressure that is used to compare with the predicted pore pressure. From RFT data in the study area, overpressure starts between the D marker and F marker in Sequence 3.

6. Acknowledgements

First, I am thankful to my supervisor Dr. Philip Rowell, for his continuous support and suggestion in this research project, and also my Professors Dr. Joseph Lambiase and Dr. John Warren for their knowledge through the Petroleum Geoscience Program. I would like to thank Chevron Thailand Exploration and Production for the use of their seismic and well log data. It is also a pleasure to thank Halliburton Company for Landmark software contributed. Moreover, I would like to show my gratitude to Chevron staff. Lastly, I appreciated my colleagues for their help and support through this research.

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