

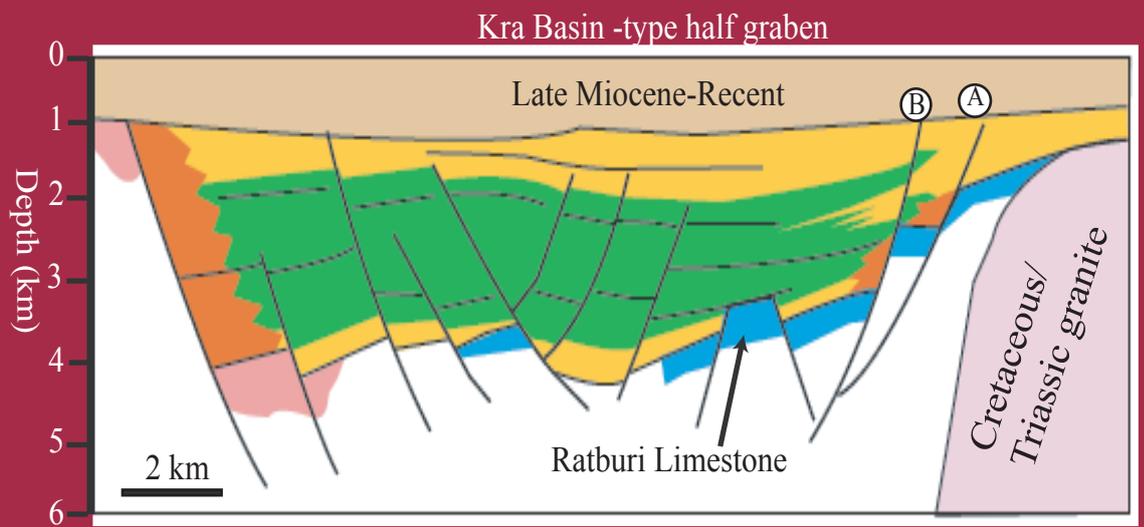
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Cover: A schematic model of the Kra Basin (page 3)

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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.

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

Structure Style and Palaeo-stress History of the Khao Thalai Area, Chanthaburi, Thailand

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Abstract

The Khao Thalai area of Chanthaburi Province is made of prominent NNW-SSE trending ridges in the surrounding flat plain. Field observations and kinematic interpretation were used to reconstruct the structural style and palaeo-stress history of the area, which is composed of a series of NW-SE to WSW-ENE trending rotated normal fault, a large NNW-SSE strike-slip fault and a series of NW-SE thrust faults. Overall, there are at least three episodes of deformation and the kinematic history of these features supports the existing regional structure model.

Keywords: Rotated normal fault, kinematic data, stress field

1. Introduction

The Chanthaburi area is characterized by a number of approximately NNW – SSE trending hills. The straightness of those hills implies fault control. Morley (2002) interpreted a branch of the Three Pagodas Fault bend to NNW-SSE and run through this area. However, to date most structural studies have focused on a large-scale assessment of the region using regional outcrop patterns, satellite images, and geophysical methods. Few detailed outcrop structural studies have been fulfilled to test the regional structural models. Thus, the objective of this study is to use detailed outcrop analysis to contribute to a better understanding of geological controls on fractures, structural style and evolution of the Khao Thalai area, as well as the regional structure evolution of southwest Thailand.

2. Methods

Fieldwork is the most critical component to this study. Structural data were gathered from outcrops including: sketches, photographs and measurements of bedding strikes and dips, lineations, fault planes,

slickensides and other kinematic indicators. Field data were processed by organizing regional structural data into specific forms (e.g. lower hemisphere equal area projections for planar and linear data). Kinematic solutions were generated to estimate paleo-stress conditions. Stereonet projection plots were also used to reconstruct the pre-fold orientations for the main structural features in the area.

3. Results

Detail studies concentrated in two main locations, namely, the Laem Thai Ran Dok Mai Peninsula (SE of Khao Thalai area) and the Laem Hin Khan Peninsula in the NW. The areas are about 10km apart (Figure 1)

3.1 Rotated normal fault at Laem Thai Ran Dok Mai

At Laem Thai Ran Dok Mai, a large wave-cut platform area along the coast exposes a great number of faults at various

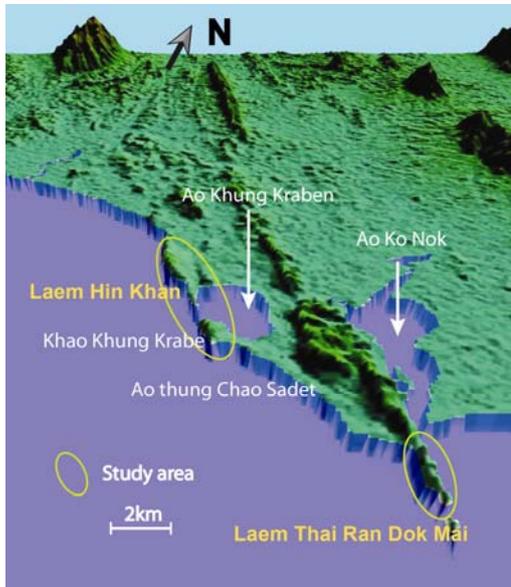


Figure 1. Location map of two main study area.

scales. The present-day geometries of the faults show strike slip motions along faults trending WSW - ENE to NW - SE and have steep to vertical dips (Figure 2a). However, the characteristics of the faults suggest that they are normal faults that were rotated during a later deformation stage to obtain the present-day geometries. Bedding dips vertically to sub-vertical and shows a consistent younging direction to the west. Thus, to obtain the common faults orientation at the time of emplacement, the faults were rotated by the relevant bedding dip to the west.

When the fault orientations are re-defined by rotating being to horizontal, it is very apparent that the faults orientation distributions are symmetric about a dominantly WNW-SSE direction. Fault kinematic data indicates a NNE-SSW to NNW-SSE oriented extension (Figure 2c and 2e).

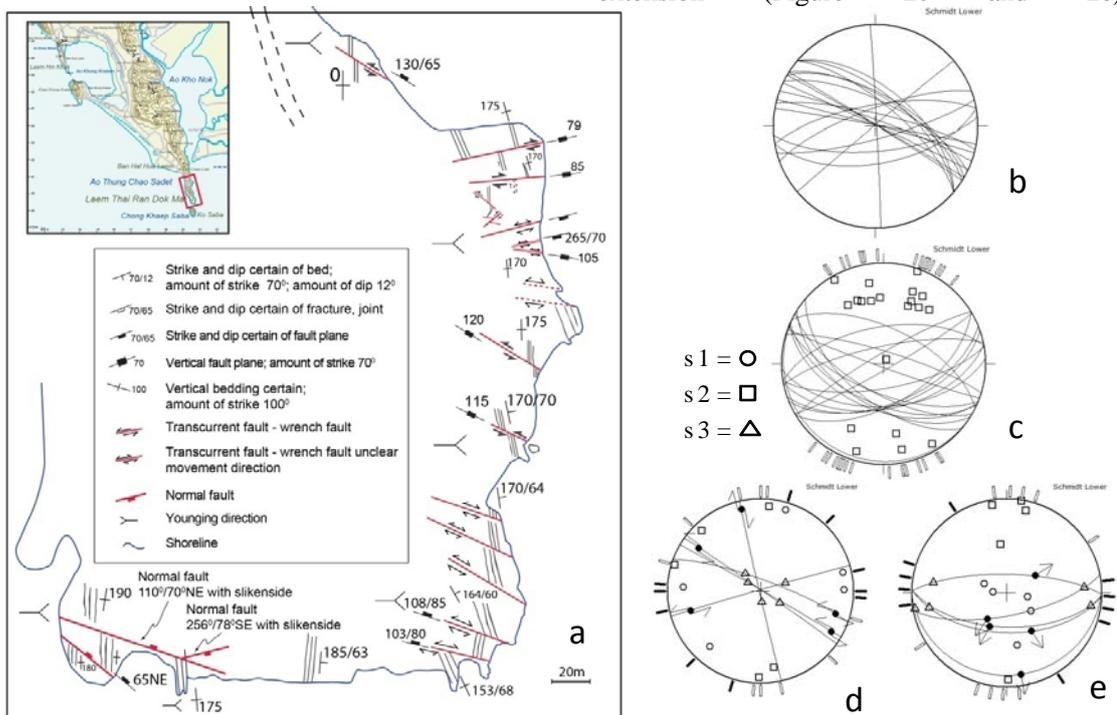


Figure 2. (a) Field summary map outcrops at Laem Thai Ran Dok Mai. (b) lower hemisphere stereographic projections of the entire major faults in present-day orientation, (c) faults after removal of bedding dips. (d) present-day orientation of five fracture plane with striae orientation.

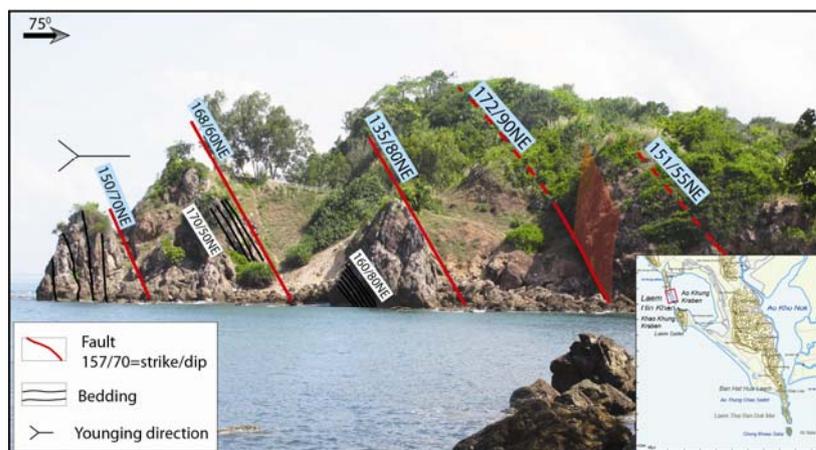


Figure 3. Morphology of the large strike slip fault at Laem Hin Khan.

3.2 Strike-slip and thrust faults at Laem Hin Khan

At Laem Hin Khan, The linear nature of the Khao Map Kho hills suggests a fault runs closely parallel to the west side of the hills. The morphology of the fault comprises an anastomosing array of sub-vertical faults (Figure 3). They all strike NNW-SSE; their dip angles vary from 60° to 90° ENE. Bedding in these fault zones also dips at a high angle toward the NE. The rocks within fault zones are also strongly altered; deformation is dominated by brittle-ductile mechanisms including cataclasis and dense fracturing, accompanied by intensive vein infills from of hydrothermal fluids. The kinematic data of the minor faults and fractures, which were generated by the major fault indicates an approximately E - W oriented maximum principal stress direction and a dextral sense of motion.

Under this E-W shortening regime, a large syncline fold was formed in the area, with the fold axis trending approximately NNW-SSE to N-S. The indicators of fold are the contrary younging directions between Laem Thai Ran Dok Mai (consistently to the west) and Laem Hin Khan (systematically eastwards).

Some faults with well-developed slickenside lineations occur in outcrops at

Laem Hin Khan. Weak fabrics and steps on the fault planes suggest a reverse sinistral sense of motion. Thrust fault planes dip at low to high angles (30° - 80°) and trend NE-SW (Figure 4). The kinematic data indicates maximum principal stress at the time of deformation was approximately sub-horizontal and NNE-SSW oriented.

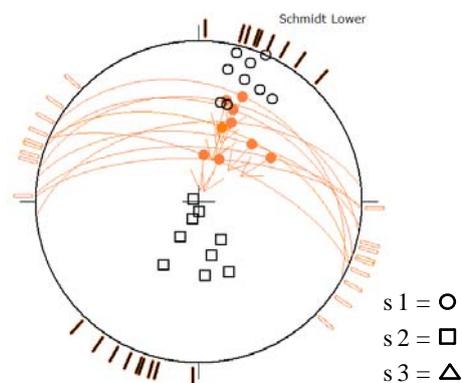


Figure 4. Fault kinematic data from thrust fault at Laem Hin Khan.

4. Discussion

In the context of the regional tectonic setting, the episode of E-W maximum principal stress, which drove the sinistral motion of the major strike-slip fault at Laem Hin Khan, is compatible with the left lateral motion phase of the Three Pagoda Fault during Eocene-Oligocene. The later and minor NNE-SSW maximum principal stress

episode regionally corresponds with a later phase (Late Oligocene-Early Miocene) of deformation along the Three Pagoda Fault zone. These observations provide the "on-ground" evidence for the previous assumption that a strand of the Three Pagoda fault crosses the study area.

However, the timing for the earlier NNE-SSW to NNW-SSE extensional phase is uncertain. They could be related to the set of extensional events, which are common observed in East and SE Asia during the Late Cretaceous to Palaeocene or it may indicate a transient stress field not yet recognized in other parts of Thailand.

5. Conclusion

A study of structure styles in the Khao Thalai area leads to the following conclusions:

(1) A number of rotated normal faults which trend ENE-WSW and NW-SE in the Laem Thai Ran Dok Mai Peninsula are evidence of first deformation episode in the Khao Thalai area. The origin and timing of the extension is uncertain.

(2) During the Eocene-Oligocene, there was a second deformation episode, it was an E-W compressional event and coincided with the sinistral motion stage of the Three Pagoda Fault.

(3) A third deformation episode occurred during Late Oligocene to Early Miocene, it was contemporaneous with the dextral motion phase of Three Pagoda Fault and kinematic data indicate NNE-SSW maximum principal stress at this time.

6. Acknowledgements

The author would like to thank the Petroleum Geoscience Program, Chulalongkorn University for providing funds for this research. Prof. C. K. Morley and Prof. John Warren and are thanked for their helpful discussions and their critical comments on the manuscript.

7. Reference

Morley, C. K., 2002. A tectonic model for the Tertiary evolution of strike-slip faults and rift basins in SE Asia. *Tectonophysics*, 347: 189-215.

Manuscript Preparation Guidelines

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Abstract

This guideline contains the instructions for preparing your manuscript. Manuscript will appear in A4-sized photocopy exactly the same as it is received. Please follow the guideline explicitly. Manuscript should be written in English and should include a concise abstract with clear statement of objectives, method, and a summary of important results. Abstract font should be #10 Time New Roman.

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