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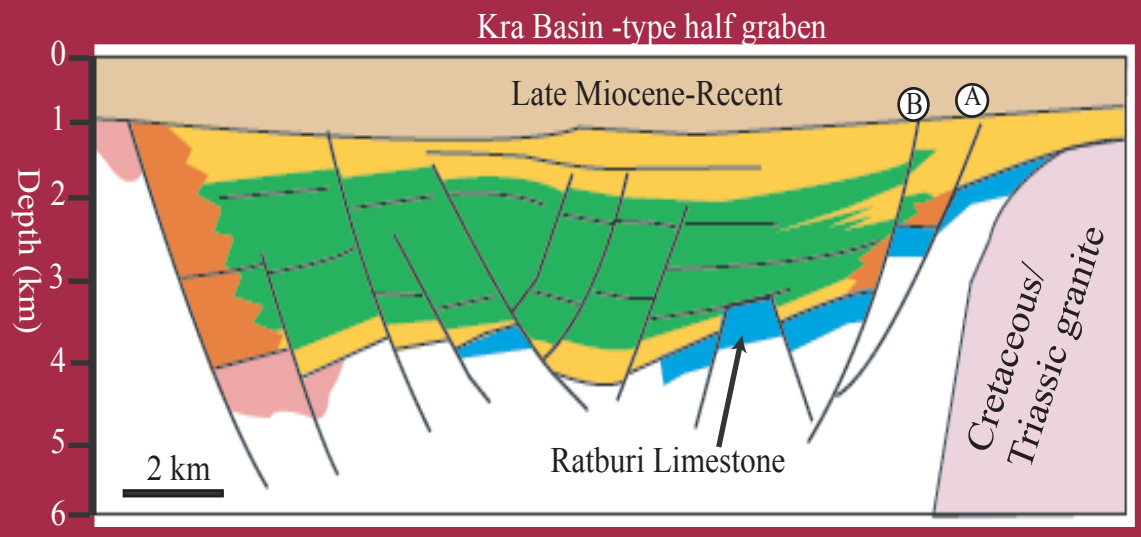

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Cover: A schematic model of the Kra Basin (page 3)

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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.

Associate Professor Visut Pisutha-Arnond, Ph.D.
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Facies Distribution and Stratigraphic Development on a Shale-Cored Ridge, Klias Peninsula, Malaysia

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Abstract

Klias Peninsula is comprised of entirely Tertiary sedimentary rocks and superficial Quaternary deposits. New sedimentological and micropaleontological data document that all sediments formed in a shoreface to shelfal setting in front of a mud rich delta. Six lithofacies defined and interpreted based on sedimentary structures, trace fossil distribution and foraminifera assemblages suggest a wave dominant open shelf. Most of the Tertiary shoreface reservoir sandstones in NW Borneo are wave dominant thus the Klias Peninsula succession is a good analogue for most of the subsurface shoreface reservoirs.

Keywords: Klias Peninsula, Shale-cored ridges, Belait Formation

1. Introduction

Klias Ridge is an example of a shale-cored ridge draped by shallow marine sandstones that form prolific petroleum reservoirs in the subsurface. There have been a few studies on the depositional environments of the Klias Peninsula but they have been inconclusive (Wilson, 1964; Drahaman, 1999). The objective of this study is to carry out detailed sedimentological studies on the Klias Peninsula outcrops, to depositional environments and interpret the stratigraphic succession.

Klias Peninsula is located on the western side of mainland Sabah and to the north of Brunei Bay in NW Borneo (Figure 1). The study area was confined to the western part of the Klias Peninsula from Tanjung Nosong in the north to Menumbok in the south.

2. Methods

The four main outcrops were logged to define grain size, sedimentary structures, bed contacts, stacking patterns and trace fossil distribution. The logs were then interpreted with respect to the sedimentary processes to determine depositional environments. Thirty shale samples were collected for microfossil analysis and these data were used to better constrain the age and depositional setting of the succession.

3. Results

Tanjung Nosong is divided into two facies (Figure 1). Clean and structureless sandstones up to 8 m thick are interpreted as upper shoreface deposits. The interbedded shale and sand facies is interpreted as lower shoreface based on a *Skolithos* ichnofacies and microfossil analysis that indicates a marine setting.

Towards the central Klias, Batu Luang includes a wide range of environments in the vertical succession (Figure 1). It ranges from braided stream to tidal channel, intertidal flat to distributary channel and lagoon to offshore.

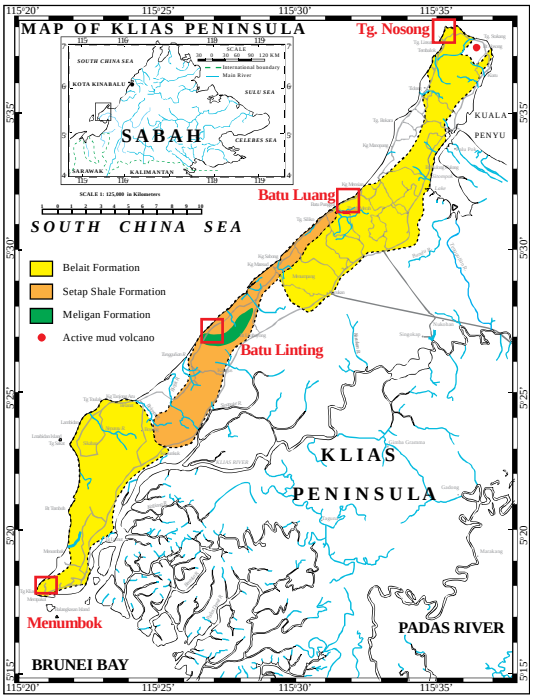

Figure 1. Location map with facies.

More than 5 m of dominantly dark grey shale with occasional thin interbedded siltstone of 3-10 cm. Shale samples yielded *Trochammina* spp. and *Recurvoides* spp. which are common in an open shelf settings. It is interpreted as a neritic, quiet open marine environment as the silty content of the shale and lack of pelagic foraminifera are evidence against it being a deep water pelagic shale (Lee, 1977).

30 m or more conglomerate with lenses of sandstone and shale follows stratigraphically after the thick shale. Most of the sandstone clasts are well rounded, elongated and up to 80 cm in length with strong imbrication and lenses of coal (Figure 2).

No trace fossils were found in the conglomerates and they are interpreted as braided stream deposits. The poorly sorted, clast-supported conglomerates with sub-angular to rounded clasts in a matrix of fine sand and mud are distinguished from a beach deposit by the high degree of sorting, very well rounded clasts and little matrix due to high energy wave action expected in a beach.

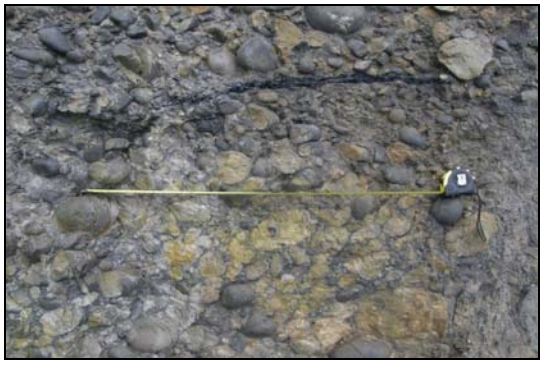

Figure 2. Conglomerate with strong imbrication and coal lenses. Scale 1 m.

Outcrops of interbedded sandstones, siltstones, shale and pebbly sandstones are characterized by thick fine to medium sandstone with conglomeratic lenses exhibiting medium scale cross bedding, parallel bedding and occasional erosive bedding. Lignitic inclusions such as coal layer and clasts occur in the pebbly sandstones. *Ophiomorpha* and *Skolithos* are common, indicating a shallow, wave influenced setting.

Figure 3. Pebbly base with lateral accretion.

The facies indicate a shallow marine setting with a fining upward succession. Both trace fossils and micropaleontology suggest deposition in a tidal channel. This is also supported by the lag deposit of the pebble sandstones on each succession (Figure 3). Internally within the sandstones, cross

bedding and erosive bedding are part of the channelized deposition.

Further southwest, Batu Linting (Figure 1) is characterized by alternating thick, fine to medium sandstones which grade upward from medium grained sand to parallel-laminated sand (in the last few centimeters) which contains abundant carbonaceous material and often capped with ripples, flasers with wavy beds (Figure 4). The unit also has flat, straight and sharp basal contacts, abundant trace fossils and occasional coal clasts. A diverse assemblage trace fossils consists of the *Cruziana* and *Nereites* ichnofacies.

Figure 4. Wavy bedding, ripples and flasers with carbonaceous material and vertical and horizontal burrows.

The sedimentary structures and some of the trace fossils found in this outcrop are identical to Menumbok Hill, which is the southernmost outcrop (Figure 1). The main difference between two is a higher shale ratio in the southern outcrop. Both are interpreted as storms deposits with Menumbok Hill representing a slightly deeper water.

4. Discussion

Klias was an open shelf with frequent storm events. This interpretation is different from previous studies based on a limited number of outcrops. The age and palaeoenvironment are well documented in the north but less so in the south. Thus, south Klias may be more complicated than the currently map (Figure 1). The Klias outcrops are suitable analogues for thinly-bedded storm sandstone reservoirs and thick, clean shoreface sands.

5. Conclusions

A study of the Klias Peninsula outcrops leads to the following conclusions; (1) Tanjung Nosong is interpreted to be upper shoreface to middle shoreface. (2) Batu Luang is interpreted to be a wide range of shallow marine environments. The overall pattern suggests a regression followed by a transgression. (3) Batu Linting is interpreted to be a shallow shelf environment with a period of intense storm events. (4) Menumbok Hills are interpreted to be a distal marine shelf with occasional storm events.

6. Acknowledgements

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