CHAPTER VI

CONCLUSION

Krabi basin is located in Changwat Krabi, the southern part of Thailand, and is elongated in the northwest-southeast direction covering on area of approximately 360 sq.km. The study area covers almost all part of Krabi basin occupying about 220 sq.km. The topography of the basin is generally flat with maximum elevation of about 50 m. above the mean sea level in the northern, western, and eastern parts, whereas the southern part is covered by mangrove.

The present investigation aims at utilizing the surface and subsurface geological and geophysical data and information in establishing the tentative and informal lithostratigraphic units and sedimentary facies for the purpose of reconstruction of depositional environments of Krabi sedimentary sequence.

The existing data and information on geology of Krabi basin from previous works, the subsurface geological and geophysical conditions obtained from drilling exploration and ground seismic survey are critically reviewed. The aforementioned data are synthesized and finally presented in various forms of subsurface maps and diagrams including 136 well data-sheets, pseudobasement structural contour map, 7 geological sections, and fence diagram.

The pre-Tertiary basinal basement rocks are believed to be the clastic sediments of Carboniferous and Permian, undifferentiated Mesozoic clastic sediments and some Permian limestone. The pre-Tertiary basinal basement rocks are unconformably overlain by the younger

sedimentary sequences of Cenozoic age.

The sedimentary sequence of Krabi Group which overlies unconformably the basinal basement rocks can be subdivided into five formations, namely, A, B, C, D, and E Formations in ascending order.

The A Formation, the lowermost formation of Krabi Group, is generally characterized by reddish-brown to grey claystone, siltstone, and white to grey sandstone interbedded with some grey limestone and carbonaceous claystone. This formation is found widely distributed throughout the basin with thickness greater than 70 m. and is considered to have tabular geometry. The A Formation is further analyzed as facies association A which is characterized by a series of fining-upward sequence from sand to clay alternate with sand-clay thinly interbedding. At least five cycles of fining-upward units and sand-clay thinly interbedding have been recognized and the A Formation can be subdivided into five lithofacies, namely, A1, A2, A3, A4 and A5. The lithofacies A1, A3, and A5 are characterized by a series of fining-upward sequence suggesting that they were deposited under the fluviatile environment. The lithofacies A2 and A4 are characterized by sand-clay thinly interbedding suggesting that they were deposited under the lacustrine environment.

Overlying conformable the A Formation is the B Formation which is characterized by grey to greenish-grey claystone, siltstone, sandstone, limestone, carbonaceous claystone, and coal with total thickness of 70-180 m. The B Formation can be subdivided into four members, namely, B1, B2, B3, and B4 Members. The lowest member of the B Formation is the B1 Member which is characterized by grey to greenish-grey claystone, sandstone, siltstone, limestone, and carbonaceous claystone with varying thickness of 20-140 m. This member is widely distributed

in the northern and central parts of the basin and absent in the southern part. The B1 Member is further analyzed as lithofacies B1 which is characterized by claystone and thinly-bedded sandstone suggesting that they were deposited under the lacustrine environment. The uppermost part of eventually passes upward into the coal of the B2 Member with sharp contact. The B2 member is characterized by coal, greenish-grey claystone, sandstone, and carbonaceous claystone with varying thickness of 20-60 m. The distribution pattern of the B2 Member is widely-spread.over the basin with tabular geometry. The B2 Member is further analyzed as lithofacies B2 which is characterized by coal with clay and sand partings suggesting that they were deposited under the coal swamp environment. It is noted that in the north-central part of study area, the coal seam splits into 2 main seams with the B3 Member of maximum 40 m. thick as major partings in between. The B3 Member is characterized by grey to greenish-grey claystone, some siltstone, and sandstone. The overall geometry of this member is considered to be lens-shaped. The B3 Member is further analyzed as lithofacies B3 and strongly suggesting that they were deposited under lacustrine environment. The uppermost of the B Formation is the B4 Member which is characterized by grey claystone, siltstone, sandstone, and limestone. The B4 Member overlies conformably the B2 Member with sharp contact. This member is distributed in two separated zones, notably, north-central zone and south-central zone. The geometry of the member is lens-shaped of 40 m. thick in the north-central, whereas in the south-central zone it is a tabular of 40-100m. thick. The B4 Member is further analyzed as lithofacies B4 which is characterized by the interbedding of clay to sand or limestone. The depositional environment of lithofacies B2 began with the coal swamp and progressively

changed into lacustrine of the lithofacies B4.

The C Formation overlies conformably the B Formation with gradational contact. This formation is characterized by grey to greenish-grey claystone, white to grey sandstone, siltstone and abundant fresh-water gastropods with varying thickness of 100-400 m. The C Formation can be subdivided into three members on the basis of lithological characteristics and sand/clay ratio, namely, C1, C2, and C3 Members in ascending order. The C1 Member is the lowest units of the C Formation which characterized by grey to greenish-grey claystone, siltstone, sandstone and limestone. The C1 Member is wide-spreadly distributed throughout the basin with varying thickness of 40-200 m. The sand/clay ratio of this member is less than 1:6. The C1 Member is analyzed as lithofacies C1 which is characterized by the claystone with abundant gastropods. The depositional environment of the C1 Member is concluded to be lacustrine. The C2 Member overlies conformably the C1 Member. This member is characterized by grey claystone, sandstone, and siltstone. The distribution pattern of the C2 Member is widely-spread over the basin with varying thickness of 40-200 m. The C2 Member has a tabular geometry. The sand/clay ratio of this member is ranged from 1:1 to 1:4. The C2 Member is analyzed as the lithofacies C2 which is characterized by a series of fining-upward sequence in the lower part, thick claystone with abundant gastropods in the middle part, and more sand-clay interbedding in the upper part. The depositional environment of the lithofacies C2 is analyzed as fluvio-lacustrine ranging from fluviatile environment in the lower part and gradually changing to lacustrine environment and eventually terminated by silting up in the uppermost part. The uppermost member of the C Formation, the C3 Member, overlies conformably the C2 Member. The C3 Member is charac-

terized by grey to greenish-grey claystone, siltstone, sandstone, and abundant gastropods. The distribution of the C3 Member is found only the southern and north-central parts of the basin with varying thickness of 20-100 m. The geometry of this member is considered to be tabular and the sand/clay ratio is less than 1:6. The C1 Member is further analyzed as lithofacies C3 which is characterized by the association of claystone, carbonaceous claystone, and siltstone. The lithofacies C2 strongly indicates the deposition in the slightly subsiding lacustrine environment.

After the deposition of lacustrine sediments of the C3 Member, the northern part of Krabi basin had been suddenly interrupted by the uplift, whereas the southern part of the basin was gently subsided. This is believed to be controlled by a series of northeast-southwest faulting in Late Tertiary. The D Formation is the topmost part of Krabi Group. This formation overlies the C Formation only in the northern part of the basin with erosional sharp contact. The D Formation is characterized by grey to reddish-brown claystone, grey to white sandstone and siltstone with varying thickness of 40-160 m. The D Formation can be subdivided into two members, namely, D1 and D2 Members in ascending order. The D1 Member is the lower member of the D Formation. This member is characterized by reddish-brown to grey claystone, sandstone, and silstone. The geometry of this member is considered to be tabular or prism with varying thickness of 40-100 m. The D1 Member is further analyzed as lithofacies D1 which is characterized by a series of fining -upward sequence. The depositional environment of lithofacies D1 is interpreted to be fluviatile. Some of the northern parts of Krabi basin, the D1 Member is overlain by the D2 Member with conformably gradational contact. The lithology of the D2 Member is characterized by grey to reddish-brown claystone, thin-bedded sandstone to siltstone,

and limestone. The geometry of this member is lens-shaped with varying thickness of 40-60 m. The D2 Member is further analyzed as lithofacies D2 which is characterized by mainly claystone with rare gastropods. The depositional environment of the lithofacies D2 is interpreted to be lacustrine.

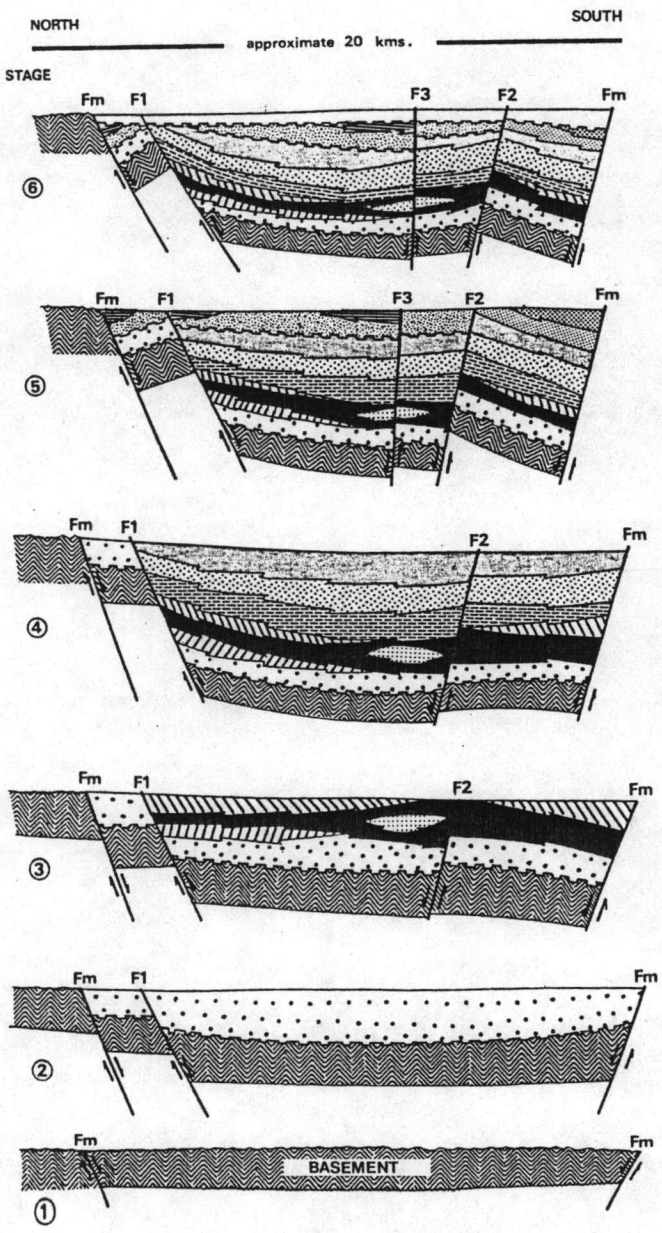
The D Formation in the northern part shows the lateral facies change into the E Formation in the southern part of the study area. It is also noted that the E Formation lies conformably on the C Formation. The lithology of the E Formation is characterized by grey to reddish-brown claystone, grey to white sandstone, siltstone, a few carbonaceous claystone, and limestone with varying thickness of 40-200 m. The E Formation can be further subdivided into two members, namely, E1 and E2 Members in ascending order. The E1 Member overlies conformably the C Formation with gradational contact. The lithology of this member is characterized by grey to reddish-brown claystone, siltstone, sandstone, and limestone. The geometry of this member is tabular with varying thickness of 40-160 m. The E1 Member is further analyzed as the lithofacies E1. The lithofacies E1 is characterized by a series of coarsening-upward sequence. The depositional environment is interpreted to be the delta front sub-facies of the deltaic environment. Overlying conformable the E1 Member is the E2 Member. The E2 Member is characterized by brown to reddish-brown sandstone and siltstone. This member is considered to be prism geometry of lens-shaped with varying thickness of 50-160 m. The distribution of this member is confined only in the central zone of the southern part of the basin. The E2 Member is further analyzed as lithofacies E2 which is characterized by a series of fining-upward sequence. The depositional environment of the lithofacies E2 is interpreted to be fluviatile of distributary channel on the upper

deltaic plain. The facies association E therefore suggests that they were deposited in the upper part of the deltaic environment prograding southwardly.

The Tertiary sediments of Krabi basin are overlain by the Quaternary deposits. The lithology is characterized by reddish-brown to grey gravel, sand, silt, and clay. The Quaternary deposits have a blanket geometry with varying thickness of 2-50 m. The fining-upward characters have been recognized. These evidences strongly suggest that they have been deposited under fluviatile environment.

The models of depositional environments of Krabi basin are summarized and presented in Figure 6.

Addtional attempt has been made to evaluate the economic potential of coal in terms of reserves and quality. The coal rank classification particularly of the ASTM (1981) has been chosen for this investigation. Altogether 132 computed calorific values indicate that the average Krabi coal rank is lignite A. The classification of geological coal reserve under the present investigation is basically based on the Classification System of U.S. Bureau of Mines and U.S. Geological Survey (1976). The geological coal reserve has been classified into 3 categories, namely, measured, indicated, and inferred reserves and the spacing of the drill-holes necessary to demonstrate continuity those reserves are less than 100 m. (greater than 100 m. drill-holes/sq.km.), 100-300 m. (9-100 drill-holes/sq.m.), and 300-500 m. (2-9 drill-holes/sq.km.), respectively. The geological coal reserves has been classified into 2 categories, namely, hypothetical and speculative resources. For hypothetical coal resource, the spacing of between drill-holes confirm the existence and quantity is



Krabi											Q	Group
A	B				C			D		E	–	Formation
–	B1	B2	B3	B4	C1	C2	C3	D1	D2	E1	E2	–	Member
													Symbol

stage 1: erosional phase of pre-Tertiary rocks; developed basinal faults (NE-SW); occured horst and graben structures

stage 2: gentle subsidence and silting up in some parts; developed F1 faults (NW-SE); deposited fluvio-lacustrine sediments (A Formation)

stage 3: gentle subsidence; developed F2 faults (NE-SW); deposition of lacustrine-coal swamp environment (B Formation)

stage 4: (Miocene) gentle subsidence; deposited lacustrine and fluvio-lacustrine sediments (C Formation)

stage 5: F2 faults (NE-SW) most active; developed F3 faults (N-S)
in the northern part; local uplift and developed unconformity; deposited fluvio-lacustrine sediments (D Formation)
in the southern part; still gentle subsidence; inundation of marine transgression; deposited deltaic sediments (E Formation)

stage 6: (Quaternary) regional uplift; the basin is covered by unconsolidated sediments

Figure 6 Simplified and idealized north-south profiles of depositional environments of Krabi basin.

greater than 500 m. (equal or less than 1 drill-holes/sq.km.). For speculative coal resource, the coal may occur in a favourable geological setting where no discovery has been made, or in deposits than remain to be recognized. The maximum thickness of coal bed employed in calculation of reserve in this study is approximately 68 million metric tons (measured reserve = 4 million metric tons, indicated reserve = 64 million metric tons) and the total Krabi coal resource is approximately 919 million metric tons.

In the conclusion, the scope of the study also limited by the availability of systematic and detailed data, financial support including technical assistance in many aspects. Therefore, conclusion on any geological aspects cannot be completely and perfectly drawn from such limitaton. However, the present study has already paved way for further detailed study. Besides, the findings of the investigation is not only beneficial for the academic point of view but also to exploration and development models of coal deposits elsewhere under the similar geological setting.