Chapter 2

Background of the Study Areas

2.1 Geographic Features

2.1.1 Sin Pun Area

The exploration area of Sin Pun is located in the central part of peninsular Thailand (latitudes 8° 7' to 8° 26' N, longitudes 99° 14' to 99° 23' E) about 800 kilometres south of Bangkok (Fig.2.1). The UTM coordinates encompassing the area under investigation include from 908000 to 918000 north and from 530000 to 538000 east as shown in topographic map sheet 4825I - 4825IV (L7017 series). The study area covers an aerial extent of about 616 km^2, encompassing parts of three Changwat (Province), Amphoe (District) Phrasaeng, Changwat Surat-Thani , Amphoe Thung-Yai and Amphoe Chawang, Changwat Nakhon-Si-Thammarat, and Amphoe Khao-Phanom, Changwat Krabi. The main channel (Khlong) in this area is Khlong Sin Pun which flows in the N-S direction through the central part of the exploration area and down to Mae Nam (river) "TAPI". Khlong Sin Pun is very meandered, its ox-bow lakes and meander scars can be usually found along the river. Small streams flow down to Khlong Sin Pun from both sides which are higher lands and formed anastomotic drainage pattern. Most of the areas were used for plantation. The major is rubber plantation and minor is for oil palm. The higher open field is farm and stock-raising.

2.1.2 Saba Yoi Area

The Saba Yoi lignite deposit about 950 kilometres from Bangkok is located in Changwat Songkhla, southern Thailand from latitudes 6°30' to 6°45' north and from longitudes 100°45' to 101°00' east.

Cross-Validation

As defined by Isaaks and Srivastava (1989), cross validation is a technique that allows us to compare estimated and true values using only the information available in our sample data set. Like the comparisons based on the exhaustive data set that we showed earlier, a cross validation study may help us to choose between different weighting procedures, between different search strategies, or between different variogram models. Regrettably, cross varidation results are most commonly used simply to compare the distributions of the estimation errors or residuals from different estimation procedures.

Kriging

As defined by Davis (1976), kriging is a method to estimate the value of the surface at any unsampled location. The estimation procedure is called 'kriging', named after D.G., Krige a South African mining engineer and pioneer in the application of statistical techniques to mine evaluation. Kriging uses the information from the semivariogram (or variogram) to find an optimal set of weights that are used in the estimation of the surface at unsampled locations. Since the semivariogram is a function of distance, the weights change according to the geographic arrangement of the samples.

The UTM coordinates encompassing the study areas are north 721,000 to 754,000 and east 7706,000 to 726,000, as shown in the topographic map 1:50,000 of map sheet 5122 II (L7010 series).

Areas to the north of the town of Amphoe Saba Yoi toward the Gulf of Thailand have less vegetation and tend to erode faster than areas closer to the mountains. Khlong Thepha, the main channel, drains into the Saba Yoi basin. This navigable river flows north to the Gulf of Thailand. The river is just east of the Saba Yoi project area. Its waters is quite fresh at Saba Yoi but it becomes increasingly brackish as it flows to the gulf. Most of the areas are used for plantation. The major is rubber plants (Fig. 2.1). Rubber trees cover almost all of the cultivated lands (Fig. 2.2). Rice, coffee, and coconut plantations are also common. In addition, most people grow local vegetables and raise goats and chickens for domestic consumption.

2.2 Geologic Background

2.2.1 <u>Sin Pun Area</u>

As shown in the regional map (Fig. 2.3), Sin Pun area is bounded by the N-trending mountain range of Mesozoic red beds in the west, east and south, and mountains of Permo-Carboniferous carbonate and clastic units to the northeast and Silurian-Devonian clastic unit to the farther east. subsurface information (Pornrattanapitak and Jitapunkul, 1985) reveals that the Sin Pun area is underlain by Cenozoic sedimentary strata, forming part of the fault-bounded intermontane basin.

The E-W tension regime developed during ca. 70-80 (Charusiri, 1989) may have been responsible for the generation of the NW and NE normal faults in this area . Such faults regarded as growth faults (syndepositional faulting) perhaps commenced in early Tertiary and continue to nearly Recent time.

The stratigraphy of deposits indicates to that the depositional environment is of fluviatile- and lacustrine- type facies which developed on the coastal plains with depositional strike in the E-W direction. It is, therefore, considered that the sea transgressed to the basin in the N-S direction (Pornrattanapitak and Jitapunkul, 1985). The detailed surface and subsurface geology (Fig. 2.4) performed by Pornrattanapitak and Jitapunkul (op. cit.) indicates that the Sin Pun basin is quite flat (see Figs. 2.5 and 2.6) and bounded by the Mesozoic rocks forming small hills within altitudes of 200-300 metres (MSL). The northern part of the Sin Pun basin is disrupted by a series of NW trending normal faults with the northern block moving upward. The boundary type in the northern part of basins is normal fault. Therefore it is an half-garben type with deepest in the north and gradually shallow to the south. The basin axis is in N-S direction. Five coal subareas (herein described as deposits) are discovered by drilling exploration from 1984-1985. Each deposit was named after the nearest village name, from north to south as Tha Khi Rad, Bang Sai, north Kuan Klang, south Kuan Klang and Nong WA. In each coal deposit, two lignite seams are recognized as shown by gamma and density log in Fig. 2.7 and are nominated as "P SEAM" and "m SEAM" in a descending order. Geology of individual coal deposits relevant to the input of database is described below.

1 Tha Khi Rad Deposit

This deposit is the smallest and non-economic potential, since its aerial extension is only about 0.12 km^2 with 10 metres of average seam thickness. It is located right at the southwestern bank of Khlong Sin Pun far away from Tha Khi Rad Village about 2 kms in northwestern direction. The major trend of this coal deposit is in the NE-SW direction and dips to the NW direction with the angle about 10°-20°. The typical character of P SEAM is hard lignite on top and gradually changes to soft lignite and ligneous clay at the bottom, respectively. Thin layers of parting (0.3-2.0 m. thick), about 15% by volume are interbedded from top to bottom.

Fig.2.1. Flat topography in Sin Pun area, showing rubber plantation.

Fig. 2.2. Flat land area with ease accessibility in Saba Yoi area, showing rubber as main crop plantation.

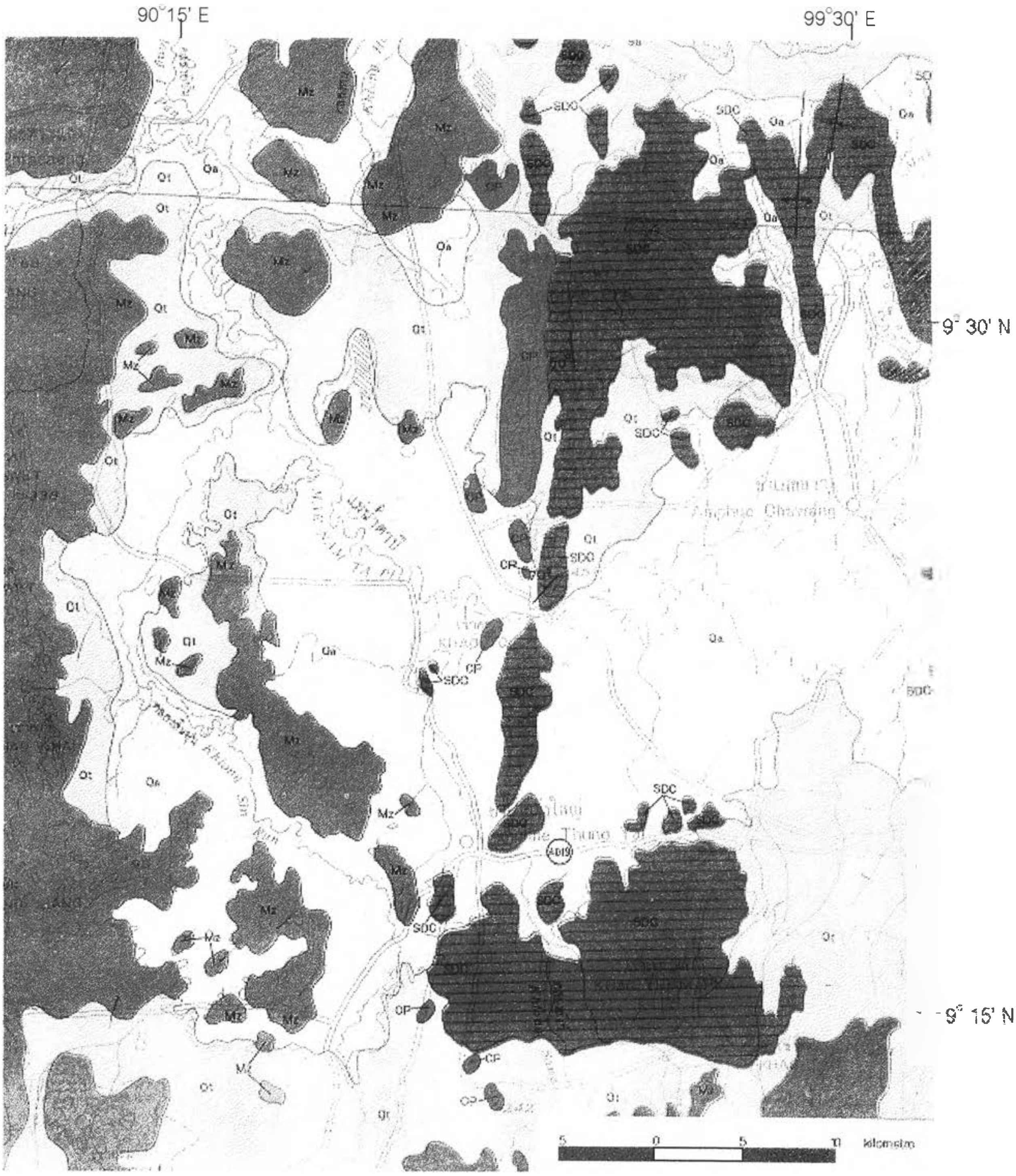


Fig. 2.3. Regional geologic map of the Sin Pun and nearby areas, data from Snansieng and others, 1979.

Explanation for Regional Geology of Sin Pun area

Sedimentary and Metamorphic Rocks		Age
Qa	Alluvial deposits ; Gravel, sand, silt, and clay.	Quaternary
Qt	Terrace, alluvial-fan, and colluvial deposits.	Quaternary
Mz	Sandstone, siltstone, and shale, and reddish-brown to brown; conglomeratic sandstone, conglomerate, and dolometic limestone, with cross-bedding, and ripple mark; and basal conglomerate.	Cretaceous-Triassic
CP	Limestone, light gray to dark gray, thin-bedded to massive; shale, sandstone, mudstone, and bedded chert with fusulinids and brachiopods.	Permian-Carboniferous
SDC	Shale, sandstone, quartzite, mudstone, and slate, well-bedded and abundant drag folds, with graptrolites.	Silurian-Carboniferous

Symbols

Boundary	Strike and dip of bedding (50)
Fault	Spot elevation in meters (242)
Anticline with plunging direction	Syncline
Road	Railroad
Drainage	Nong, Bung (Pond)

The thickness of P SEAM is about 10 metres in the shallow area and it is gradually thinning along down dip direction until absent from stratigraphy. This is lateral facies change from coal layer to clastic sediments layer. The M SEAM is very thin with thickness less than 0.5 metres and does not uniform throughout the resource deposit.

2 Bang Sai Deposit

Bang Sai deposit is located at Bang Sai Village, far from Tha Khi Rad deposit about 2 kms in south direction. It is the second large deposit whose surface area is about 1 km^2. The longest portion is 2.5 kms and most width portion is 0.5 km. The geometry of coal seam is tabular shape with NE-SW and east-west trends from place to place. It dips to northwest and north with angle of 10°-20°. P SEAM consists largely of hard lignite on top and gradually change to soft lignite and ligneous clay at the bottom. About 10-15 percent by volume of parting are interbedded throughout the seam. The parting thickness varies from 0.3 to 2.0 metres and the parting comprises silty claystone and fossiliferous beds. The average thickness of P SEAM is about 13 metres. The P Seam is gradually thinning along down dip direction until absent from stratigraphic sequence at depth around 80 metres from ground surface. Depending upon splitting nature of the seam, it can be divided into 4 subseams as P1, P2, P3 and P4. The M SEAM is poorly developed throughout the deposit with thickness ranging from 0.5 to 2.0 metres.

3 North Kuan Klang Deposit

The deposit is located in northern area of Kuan Klang village and continues to Khok Khrai village, and far away from Bang Sai deposit about 1 km in south direction. Therefore it is the largest resource which covers a surface area of about 1.5 km^2 . The longest portion is about 3.5 kms and the widest portion is 0.9 km.

The geometry of coal seam is tabular in shape with trending in NE-SW and east-west direction from eastern to western portion, respectively. Both coal seams dip to north and northwest at the angle of 10^{o}-30^{o}. The typical character of P SEAM is similar to that of the Bang Sai deposit. The estimated volume of parting interbedded throughout the seam is about 10-15 %. Parting's thickness varies from 0.1 to 1.0 metre and the parting comprises silty claystone and fossiliferous beds. The better character of P SEAM is developed at depth more than 150 metres from ground surface as hard lignite on top and gradually changing to soft lignite in the bottom. The thickness of P SEAM is about 13 metres. In the eastern portion of the deposit, it is gradually thinning along down dip direction until absent from its stratigraphic sequence at depth around 80 metres from ground surface. In the eastern portion of the deposit, it is gradually thinning until absent from stratigraphy at depth of 190 metres from ground surface. Depending on splitting nature of the seam, it can be divided into 4 subseam as P1, P2, P3 and P4 . The M SEAM is well developed throughout the deposition with thickness vary from 0.5-2.0 metres.

4 South Kuan Klang Deposit

It is located in the southern area of Kuan Klang village and far away from north Kuan Klang deposit about 0.5 km in south direction. It is the fourth large deposits and covers the surface area of about 0.7 km^2 . The longest portion is 1.7 kms and the most width portion is 0.4 km. The geometry of coal seam is tabular in shape with NE-SW trend. Coal seam dips gently to NW direction at the angle of about 10^{o}-20^{o}. The typical character of P SEAM is similar to that to Bang Sai deposit. About 10% by volume of parting are interbedded throughout the seam. The parting's thickness varies from 0.3 to 1.0 metre. The parting comprises silty claystone and fossiliferous bed.

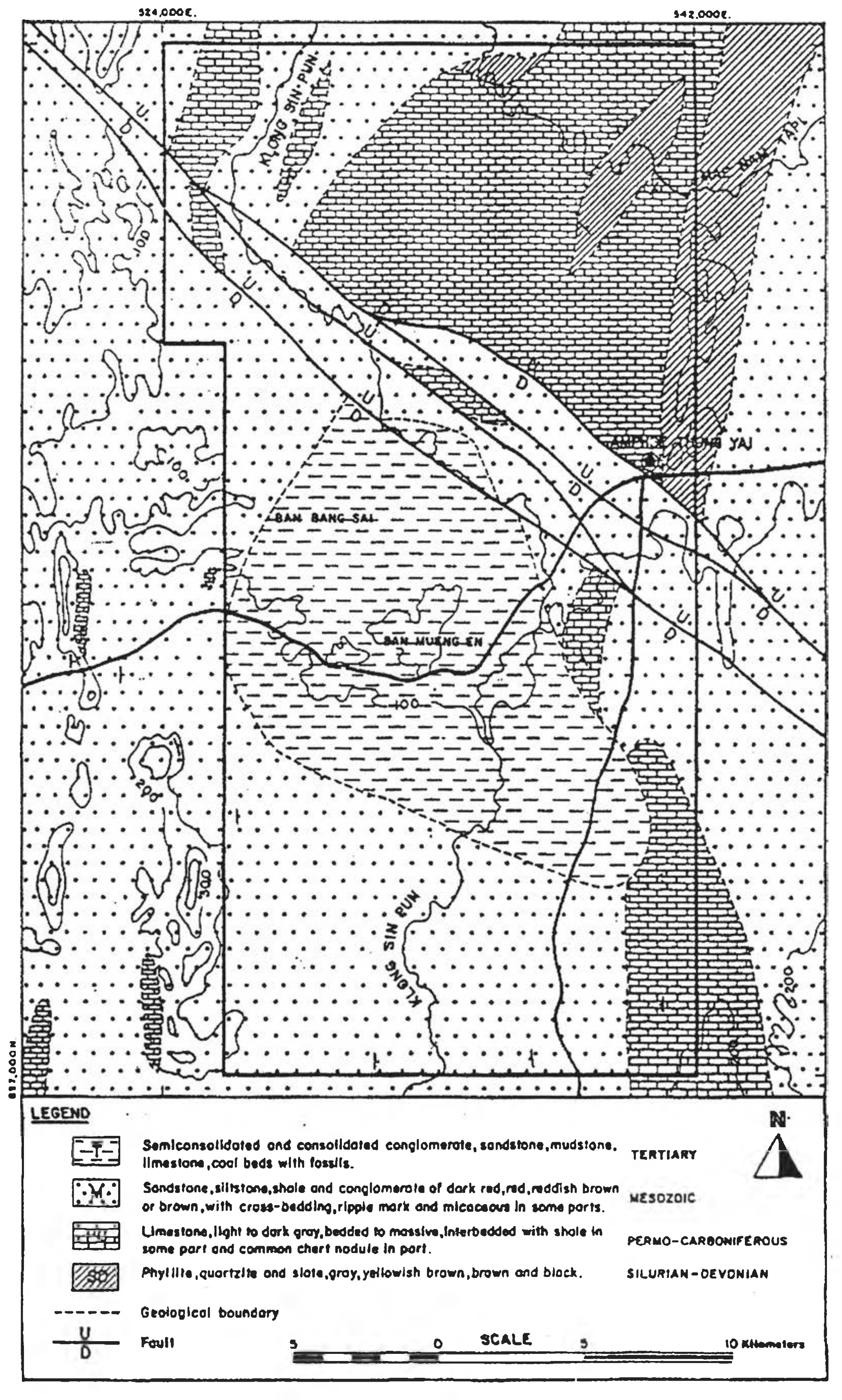


Fig. 2.4. A detailed geologic map of the Sin Pun area, data from Pomrattanapitak and Jitapunkul (1985).

Fig. 2.5. Overview of flat-plain Sin Pun area showing a small monack knob of Permo-carboniferous limestones (photo taken to NE direction).

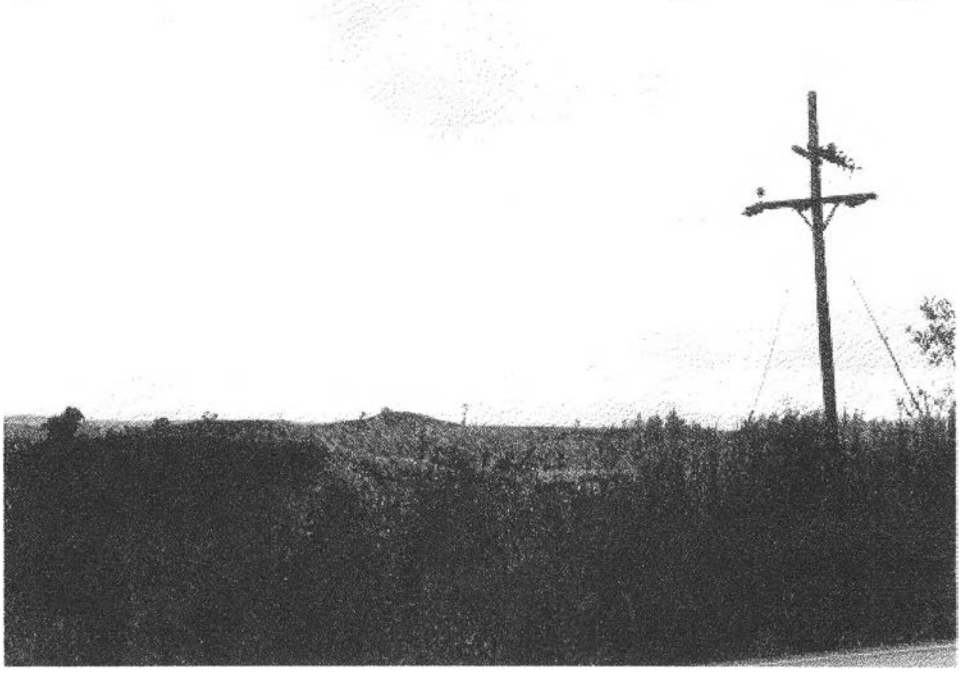


Fig.2.6. Overview of very gentle slope to flat terrain of the Sin Pun area (photo taken to the east).

5. Nong Wa Deposit

This deposit is situated in the eastern bank of Khlong Sin Pun. It is far away from south Kuan Klang deposit about 2 kilometres in SE. The area is about 1 km^2 . Its maximum length is about 2 kilometres. The maximum width portion is about 0.7 km. It is likely tabular in geometry with NW-SE trend. Coal seam dips to NE direction with angle of about 10°-20°.

The typical character of P SEAM is similar to that of Bang Sai deposit. About 10-20% by volume of parting are interbedded throughout the seam. The parting's thickness varies from 0.3 to 1.0 metre. The parting is composed of fossiliferous beds and silty claystone. The thickness of P SEAM is about 10 metres. The seam is gradually thinning or highly splitting along down dip direction from place to place.

Depending on seam-splitting nature the P SEAM can be, as well, divided into 4 sub-seams as P1, P2, P3 and P4. The M SEAM, the lower coal seam, is poorly developed in this deposit with the thickness of less than 1 metre (see Fig. 2.7).

2. Saba Yoi Area

Regionally, the Saba Yoi area (Fig. 2.8) is located in the so-called Saba Yoi Basin (Muenlek and others, 1980). The basin is bounded to the south by mountains of the Carboniferous rocks including greenish-gray, shale, medium- to coarse- grained sandstone, chert, and conglomerate. To the east, it is bordered by this Carboniferous unit and the Triassic granites with pegmatitic dykes, and to the west by Tertiary strata with fossiliferous shale, marl and sandstone as dominant rocks. To the west, it is bordered by the Permian limestone (Muenlek and others, 1980).

The detailed subsurface geology made by Nakapadungrat and others (1988) indicates that the Saba Yoi basin was bounded by sandstone, siltstone, mudstone, shale, chert and conglomerate of Carboniferous in the south and east of Amphoe Saba Yoi, and conglomerate, mudstone (Tr1), sandstone, shale (Tr2), and limestone (Tr3) of Triassic in the western part. The sandstone, siltstone, and shale in Tertiary was found in the south-west of Amphoe Saba Yoi. The 45% of Quaternary sediment cover in this area can be divided as belows:

- high terrace deposit (Qft1);
- low terrace deposit (Qft2);
- flood plain deposit (Qff);
- alluvium complex deposit (Qfx); and
- meandering belt deposit (Qfm).

Nakapadungrat and others (1988) reported that limestone in western part show the smaller forraminifera, aulotortus sp., algal fragments coated by lithocodium micrite, indicated Triassic age. (referred by Grant-Mackie and others, 1980). Grant-Mackie and others (1980) discussed that limestone Triassic in Saba Yoi area different with Kodiang limestone, show Anisian-Karnian of Conodont in Kida State , Malasia. They compared conglomerate in Tr1 like conglomerate in Phra That Formation, Lampang Group.

The porphyritic biotite granite distributed in the north-west of Saba Yoi basin. The three main faults in NE-SW, NW-SE, and N-S are important factors to move coal status in Saba Yoi basin to the shallow. Flat topography (as shown in Figs. 2.9 and 2.10) with very gentle slope northward is vary characteristic in the area under investigation.

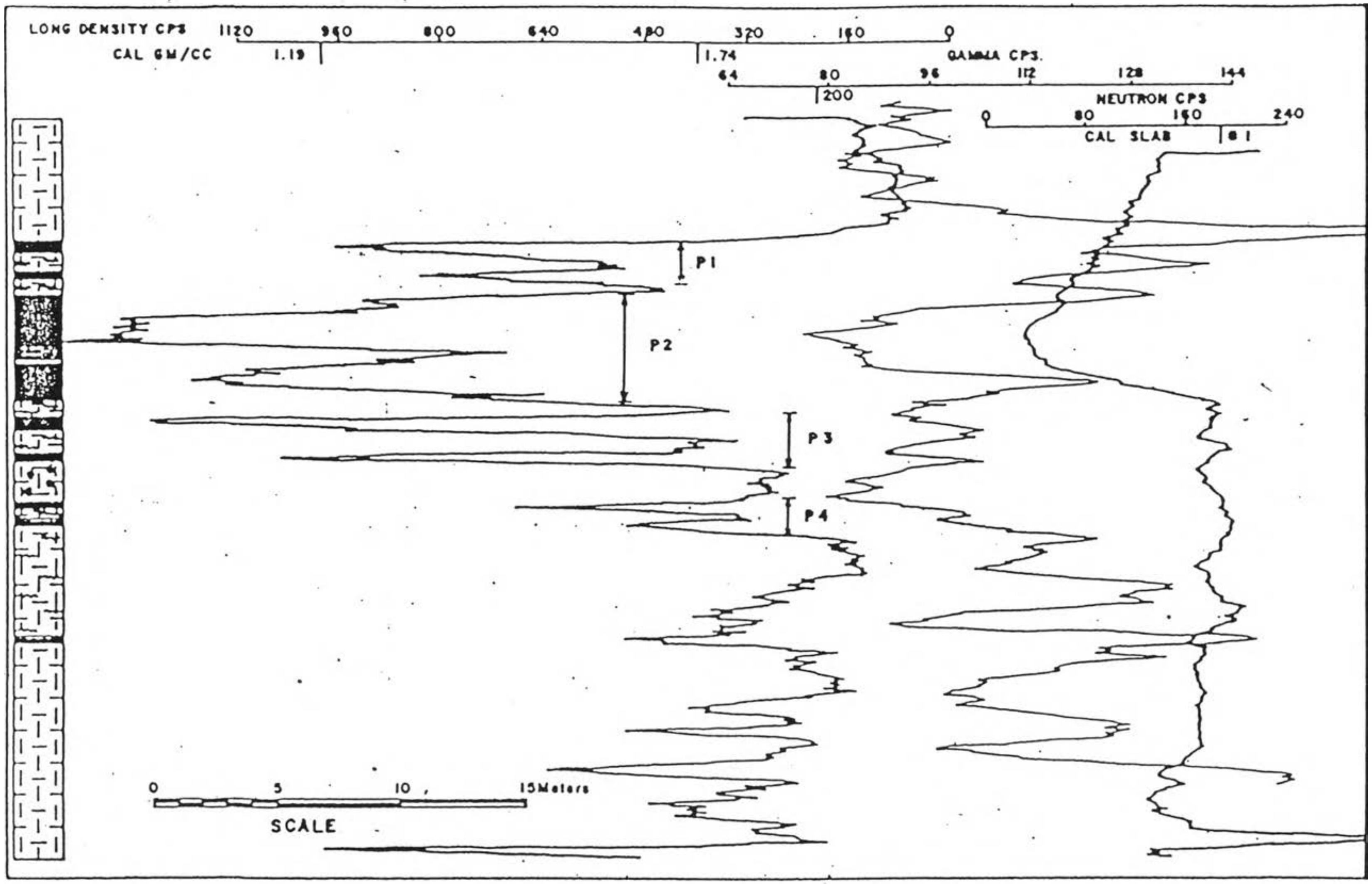


Fig. 2.7. Typical "P" SEAM and "M" SEAM of Nong Wa area with sub-seam detected by bore-hole logging, data from Pornrattanapitak and Jitapunkul (1985).

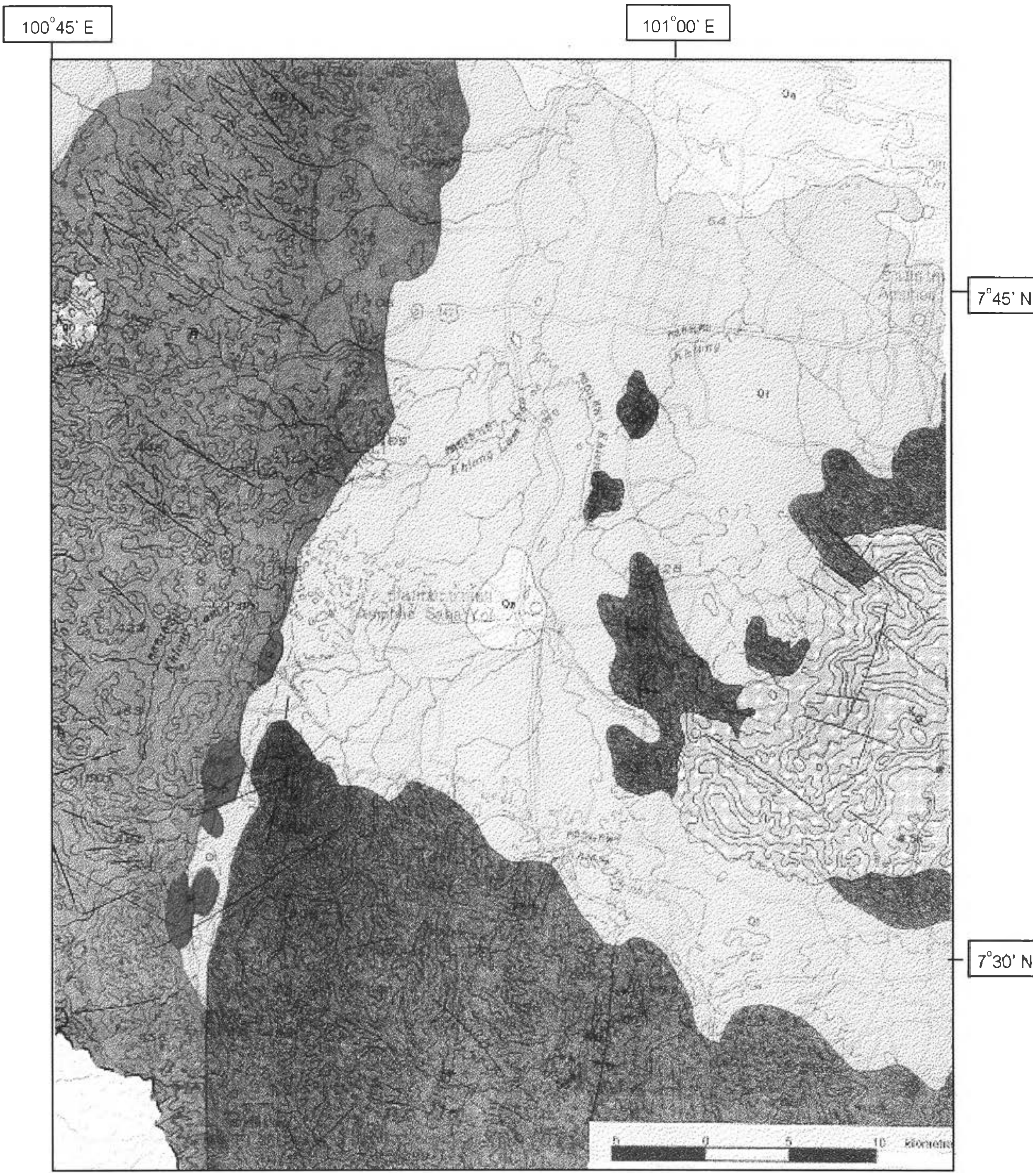


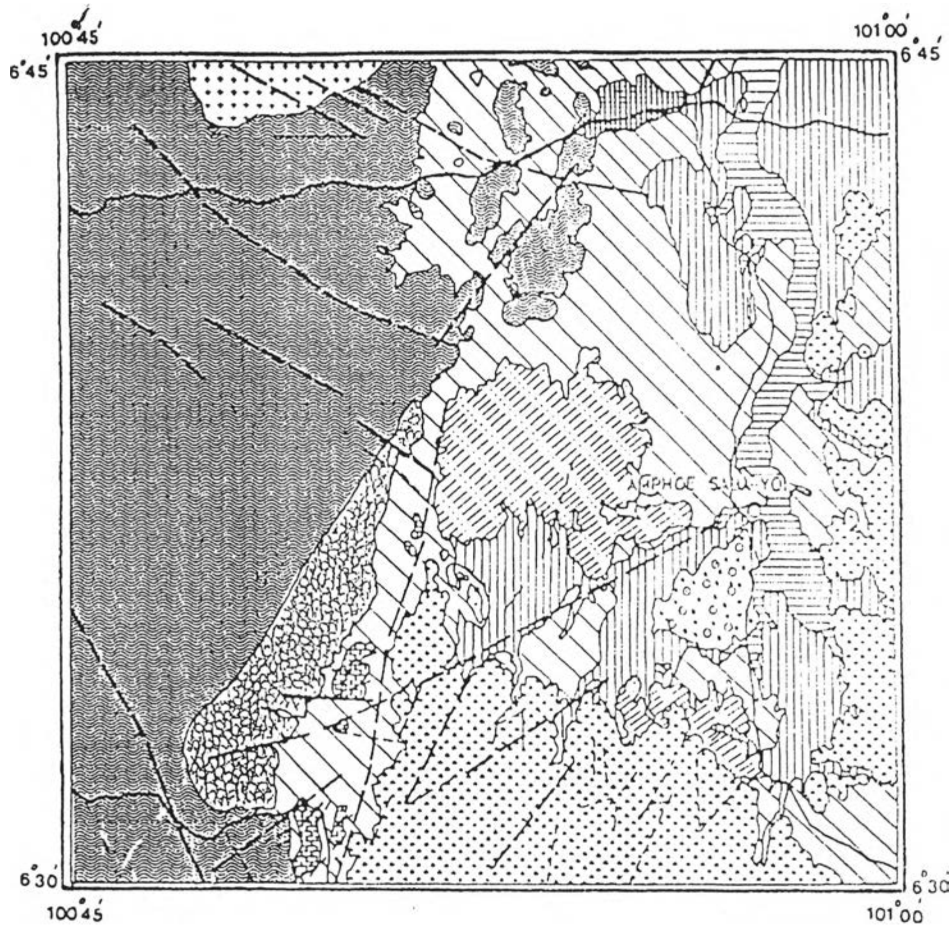
Fig. 2.8. A regional geologic map of the Saba Yoi and nearby areas, data from Muenlek and others, 1980.

Explanation for Regional Geology of Saba Yoi area

	Sedimentary and Metamorphic Rocks	Age
Qa	Alluvial deposits ; Gravel, sand, silt, and clay ; recent and old beach sand.	Quaternary
Qt	Terrace deposits ; Gravel, sand, silt, clay, and lateritic soils.	Quaternary
TR	Conglomerate, sandstone, siltstone, mudstone and shale, greenish-gray to brown, with Daonella, Posidonia, and ammonite trace.	Triassic
P	Recrystalline limestone, light gray to white, massive and well-bedded ; and marble.	Permian
Cy	Shale, greenish-gray, well-bedded; sandstone, white to brown, medium to coarse-grained; siliceous shale; chert, shale with cross-bedding; and conglomerate.	Carboniferous
	Igneous Rocks	**Age**
Gr	Granite, quartz-monozonite, pegmatites, aplite, and fine-grained tourmaline-granite.	Cretaceous

Symbols

Boundary	Strike and dip of bedding (20)
Fault	Spot elevation in meters (1174)
Anticline with plunging direction	Syncline
Road	Railroad
Drainage	



Explanation

Meandering belt deposit	Quternary (Qfm)
Alluvium complex deposit	Quternary (Qfx)
Flood plain deposit	Quternary (Qff)
Low terrace deposit	Quternary (Qft_2)
High terrace deposit	Quternary (Qft_1)
Sandstone, siltstone, shale	Tertiary (Te)
Limestone	Triassic (Tr_3)
Conglomerate and mudstone	Triassic (Tr_2)
Sandstone, shale, siltstone	Triassic (Tr_1)
Sandstone, shale, chert and conglomerate	Carboniferous (C)
Porphyritic biotite granite	Triassic (Tr Gr)

Fig. 2.9. A detailed geologic map of the Saba Yoi area data from Nakapadungrat and others, 1988.

Fig. 2.10. Overview of Saba Yoi area, showing the almost flat terrain with hill of Carboniferous rocks in the background (photo to NNE).

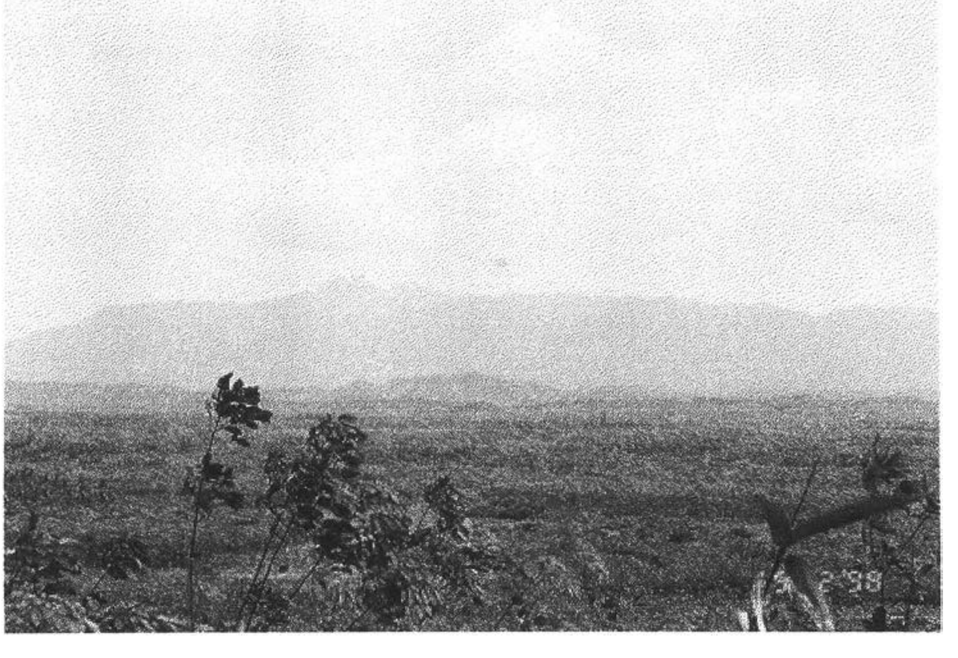


Fig.2.11. The flood-plain-dominated Saba Yoi area as view to the NW, showing the high mountain of Carboniferous rocks.

Drilling exploration indicates that at least 5 deposits area encountered on the basis of shallow seismic reflection method. Geology of individual coal deposits is summarized as follows:

2.1 Ban Sao Deposit

It is located in the westernmost portion (see also Fig. 2.8) of Tertiary basin. It covers the surface area of about 4.27 square kilometres. Shape of the deposit is similar to an equal triangle of 1.5 kilometres per side. The major trend of this coal deposit is in NE-SW direction and dip to NW direction with the angle of 5^{o}-10^{o}. Seam thickness varies considerably from 6.0 metres to 31.0 metres.

The typical character of coal seam is hard lignite on top and gradually changing to clayey lignite and ligneous clay in the bottom, respectively. Percentage of parting is less than 10% on top and gradually changed to more than 50% in the bottom. Parting thickness varies from 0.2 metres to 4.0 metres. At SE of Ban Sao Deposit, it's lateral facies change from coal layer to claystone on bottom of coal seam.

2.2 Ban Khok Tok Deposit

It located far away from Ban Sao deposit about 0.5 to 0.8 kilometres in east direction. It covered surface area about 4.63 square kilometres. The longest portion is 3.5 kilometres and most width portion is 15 kilometres.

The major trend of this coal deposit is in the NE-SW and NNE-SSW direction from southern to northern part. It dips to NW and NWW with the angle of 10^{o}-20^{o}. Seam thickness varies significantly from 6.0 metres to 36 metres.

The typical character of coal seam is hard lignite and clayey lignite with 0%-30% parting on bottom and the seam changes to more parting on top parting. In the northern part, it is hard lignite and clayey lignite with 0%-30% parting on top and gradually changing to ligneous clay and clay in the middle and claystone in the bottom portion. Most of all parting thickness ranges dramatically from 0.1 metre to 30.0 metres.

2.3 Ban Khok Ok Deposit

Ban Khok Ok deposit is situated immediately east of Ban Khok Tok Deposit. The major trend of this coal deposit is in the NE-SW direction. It dips to NW with angle 5^{o}-15^{o}. Seam thickness varies from 13 metres to 57 metres in southern part and gradually thinning in northern part. The typical character of this coal seam consists of lignite with 35% parting as top and gradually changes to lignite with 50% parting in the middle and gradually to lignite with 10% parting at the bottom portion. In the northern part, the coal seam consists of lignite with 15% parting on top and gradually change to 60% parting in the middle, 90% parting at the bottom portion.

2.4 Ban Bao Deposit

This deposit is located near by Ban Bao village. The major trend of this deposit is in the NE-SW direction and dip direction is to the NW with angle in range 10^{o}-15^{o}. The typical character of coal seam is hard lignite right at the top and gradually and vertically changed to clayey lignite, ligneous clay and clay at the bottom respectively. The coal seam thickness is about 8 to 29 metres.

2.5. Ban Kho Lo Mu Do Deposit

This deposit cover Ban Ko Lo Mu Do, Ban Nut and adjacent area. This deposit is regarded as the smallest among all of the deposit. It was firstly discovered in 1988. The coal seam is bounded by NW-SE fault system in the north. The thickness of coal seam is about 15 to 17 metres. The major trend of the deposit is in the NE-SW direction. It dips to NW direction with angle about 10^{o}-18^{o}.

More details of the Saba Yoi area is studied (see Marston & Marston, 1990). It is more promising target than that of the Sin Pun, so far the lignite zone of the Saba Yoi area is divisible into 4 major seams (Fig. 2.12). The seams have been designated in stratigraphically descending order as S1, S2, S3, and S4.

The *S1 SEAM* principally occurs along the southern extension of the Saba Yoi basin in the Ban Khok Tok, Ban Khok Ok, Ban Bao, Ban Suan Nai and Ban Kho Lo Mu Do sub-areas. The S1 SEAM is composed mostly of ligneous clay and clayey lignite. Clay, soft lignite, and hard lignite also occur as well in the S1 SEAM. Based on drill hole data, the S1 SEAM thickness ranges from 2.85 to 16.40 metres with an average of 7.59 metres.

The *S2 SEAM* is further subdivided into S2A, S2B1, S2B2, and S2B3 sub-seams. The S2B1 and S2B2 sub-seams are primarily ligneous clay and clayey lignite that or correlatable horizons within the drill hole data. The S2A and the S2B3 sub-seams are characterized by clay and sandy clay with thin stringers of ligneous matter. The S2A and S2B3 sub-seams are observed to increase in thickness and occurrence toward the SE portion of the basin. The increase in thickness is attributed to increased fluvial deposition. The more detailed investigation from drilling data advocates that the S2A parting contains sparse ligneous matter and never develop correlatable ligneous horizons.

The S2B1 sub-seam is composed largely of ligneous clay with occasional clay and soft lignite. The S2B1 occurs sporadically in the Ban Khok Tok, Ban Khok Ok, Ban Bao and Ban Suan Nai sub-areas. The S2B1 thickness varies between 1 and 15 metres with an average of 7.72 metres based on drill-hole data. The S2B1 seam occurs only in the southern portions of the Saba Yoi basin and pinches out to the north where the affects of the fluvial systems decrease. Compared to the S2B2 seam, the S2B1 has poor quality. The sporadic occurrence and variable thickness of the S2B1 sub-seam imply that the S2A sediments have washed out the seam locally. The sporadic occurrence and variable thickness of the S2B1 sub-seam imply that S2A sediments have washed out the seam locally. Thin partings of clay and sandy clay make the quality of the S2B2 seam variable, ranging from good to poor quality lignite.

The S2B3 sub-seam increases in thickness and arial extent of the Ban Suan Nai and Ban Kho Lo Mu Do sub-areas. The sub-seam is considered to have occurred as a result of an increased in fluvial deposition.

The *S3 SEAM* is subdivided into 3 sub-seams, S3A, S3B, and S3C. In sub-area Ban Sao, Ban Bao, the northern part of Ban Khok Ok, and Ban Khok Tok, it is further subdivided into S3B1 and S2B2 sub-seams. The S3B sub-seam is regarded the most well developed coal seam in the Saba Yoi Basin and in the areas where S3B1 and S3B2 are distinguished, the S3B1 posses the highest quality. The thickness and quality of S3 SEAM deteriorates in the Ban Suan Nai and Ban Ko Lu Mu Do sub-areas, possibly as a result of the fluvial activity in those sub-areas.

The S3A sub-seam containing less stiff clays with low plasticity, is low quality, and occurs sporadically directly above the S3B sub-seam. The S3B sub-seam consists chiefly of clayey lignite, hard lignite and soft lignite. The S3B2 sub-seam which is thicker than S3B1 is composed of clay, ligneous clay, clayey ligneous, soft lignite and hard lignite, with ligneous clay and clayey lignite predominating. Thickness of S3B2 sub-seam ranges from 1-17 metres with an average of 9.26 metres based on drill hole data. The S3B1 and the S3B2 sub-seams are very well developed in the Ban Sao and Ban Bao sub-areas.

The quality of the S3B2 sub-seam varies as the amount of ligneous clay varies within the seam. The higher ligneous lay content of the S3B2 sub-seam compared to the S3B1 sub-seam points to a gradual increase in the factors optimizing the formation of peat swamps. The high ligneous clay content of the S3C sub-seam make the seam have low quality.

The *S4 SEAM* which is divided into 3 sub-seams, S4A, S4B, and S4C, consist mainly of interbedded clay and sand with ligneous clay and clayey lignite. The S4 SEAM is associated with the fluvial deposition process as those of the S1 and S2 seams. The S4A sub-seam with variably thickness consists primarily of interbedded clay, sandy clay and sand with stringers of ligneous clay or clayey lignite. The ligneous stringers (1.5 metres thick) of the S4A sub-seam shows limited lateral extent gives rise to low quality. The S4B sub-seam is also composed of interbedded clay, sandy clay, and sand with ligneous stringers. This sub-seam, with considerably change in thickness, extends throughout all the sub-areas in the Saba Yoi Basin. The S4C sub-seam with limited extent is composed largely of claystone, clay and ligneous clay with occasional stringers.

TYPE	COLUMN	UNIT	DESCRIBTION	THICKNESS
Overburden		T2	A thick unit above lignite zone. the T2 unit a fine grained lacustrine subunit. T2L. and a coarse grained fluvical subunit T2F.	0.60-375.0
LIGNITE ZONE		S1	Mostly of ligneous clay. clayey lignite & lignite with partings of clay and sand.	2.85-16.40
		S2A	Interbedded clay. sandy clay. sand and gravel. Contains minor ligneous stringers.	1.00-83.00
		S2B1	Interbedded clay and ligneous clay with sporadic soft lignite	1.00-15.00
		S2B2	Ligneous clay. clayey lignite. and lignite. with partings of sand and clay of variable thickness.	
		S2B3	Interbedded clay. sandy clay. sand and gravel. Poor quality ligneous stringers common.	1.00-14.75
		S3A	Ligneous clay or dark gray clay. Sporadic occurence.	0.40-8.00
		S3B	Clayey lignite and lignite with minor partings of clay. sand and gravel. S3B1 & S3B2 subseams. Ligneous clay. clayey lignite and lignite. Parting of sand and clay seperating .	
	■	S3B1	S3B1 and S3B2 subseams. second best lignite quality subseam.	1.10-24.00
		S3B2		1.00-17.00
		S3C	Interbedded ligneous clay. clay. clayey lignite and sand sporadic occurence.	0.54-6.30
		S4A	Interbedded clay. sandy clay. sand and gravel. Ligneous stringers common.	1.00-21.00
		S4B	Carboniferous clay. ligneous clay. clay and sand. Ligneous content exceeds ligneous matter in S4A subseam.	0.50-24.00
		S4C	Claystone. clay and ligneous clay. limited extent.	7.70-27.00
UNDER BURDEN		T3	Thick unit below underburden with a fine grained lacustrain subunit T3L and a coarse grain fluvial unit. T3F.	1.00-336.00

■ Best lignite quality subseam

Fig. 2.12. Stratigraphic column recorded by bore-hole logging with ranges of thickness, Saba Yoi lignite zone (modified from Marston & Marston, 1990).