No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINERALS AND GEOSCIENCE DEPARTMENT(MGD)
MINISTRY OF PRIMARY INDUSTRY
MALAYSIA

THE STUDY
ON
COAL EXPLORATION AND ASSESSMENT
IN
SABAH, MALAYSIA

FINAL REPORT

SUMMARY

September 1999

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MITSUI MINING ENGINEERING CO., LTD.
NIKKO EXPLORATION AND DEVELOPMENT CO.,LTD.
JAPAN

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1. Introduction

1.1. Outline of the Study

1.1.1. History of the Study

In response to the request of the Government of Malaysia, the Government of Japan decided to conduct a Study on Coal Exploration and Assessment in Sabah, Malaysia (the Study). The Scope of Work for the Study was agreed upon between Geological Survey Department Malaysia (GSD) and Japan International Cooperation Agency (JICA) on 21 November 1996.

The study consists of two phases and Phase 1 study was carried out from March 1997 to March 1998. At the Evaluation Committee Meeting held in Kuala Lumpur on 11 march 1998, a decision was made to proceed to Phase 2 based on the result of Phase 1 study. Phase 2 study was commenced in July 1998 and all the field investigations and the studies in Malaysia were completed in March 1999. Further study was carried on in Japan to complete this final report, which incorporated all the results of Phase 1 and Phase 2 studies.

Since 1st July 1999, Geological Survey Department (GSD) has been referred as Minerals and Geoscience Department (MGD) following the merger of Geological Survey Department and Mines Department. In this report, however, the former name is used as the counterpart agency of the Malaysian Government.

1.1.2. Objective and Scope of the Study

(1) Objective of the Study

The following is the overall objective of the Study as defined in the "Scope of Work":

(a) To conduct coal exploration and assessment in the Malibau and Silimpopon-Serudong Basins. The study area is shown in Figure 1-1.

(b)To transfer technology and know-how to GSD personnel in the course of the cooperative study both in Malaysia and Japan.

(2) Scope of the Study

The Study consists of two phases and the scope of the study in each stage are as follows:

(a) Phase 1 - Geological reconnaissance survey in the whole study area and preliminary evaluation of coal resources

(i) Collection and analysis of existing information, data and reports

(ii) Geological reconnaissance survey

(iii) Coal sampling and analysis

(iv) Evaluation of coal resources - reserves and quality

(v) Preliminary appraisal of mining potential

(b) Phase 2 - Detailed geological mapping, preliminary mining plan, initial environmental examination and recommendation on coal resource development

(i) Photogrammetric mapping at a scale of 1:10,000

(ii) Detailed geological mapping in the selected areas

(iii) Coal sampling and analysis

(iv) Evaluation of coal resources - reserves and quality

(v) Preliminary plan of coal mine development

(vi) Initial environmental examination

(vii) Evaluation of potential and recommendation for coal mine development

Overall schedule of the study is shown in Figure 1-2.

1.2. Background of the Study

1.2.1. Energy Policy in Malaysia

In the past, energy consumption in Malaysia was primarily dependent on imported oil.After the second oil crisis in 1988, however, nation's strategy was shifted to conserve existing oil reserves and to increase gas utilization for the purpose of decrease in oil dependence and diversification of energy sources.

This strategy was succeeded by "Four Fuel Energy Policy ", which is the principle of the present energy policy and pursues diversification and balanced utilization among the four energy options - oil, gas, hydro and coal. An important part of this policy is the priority

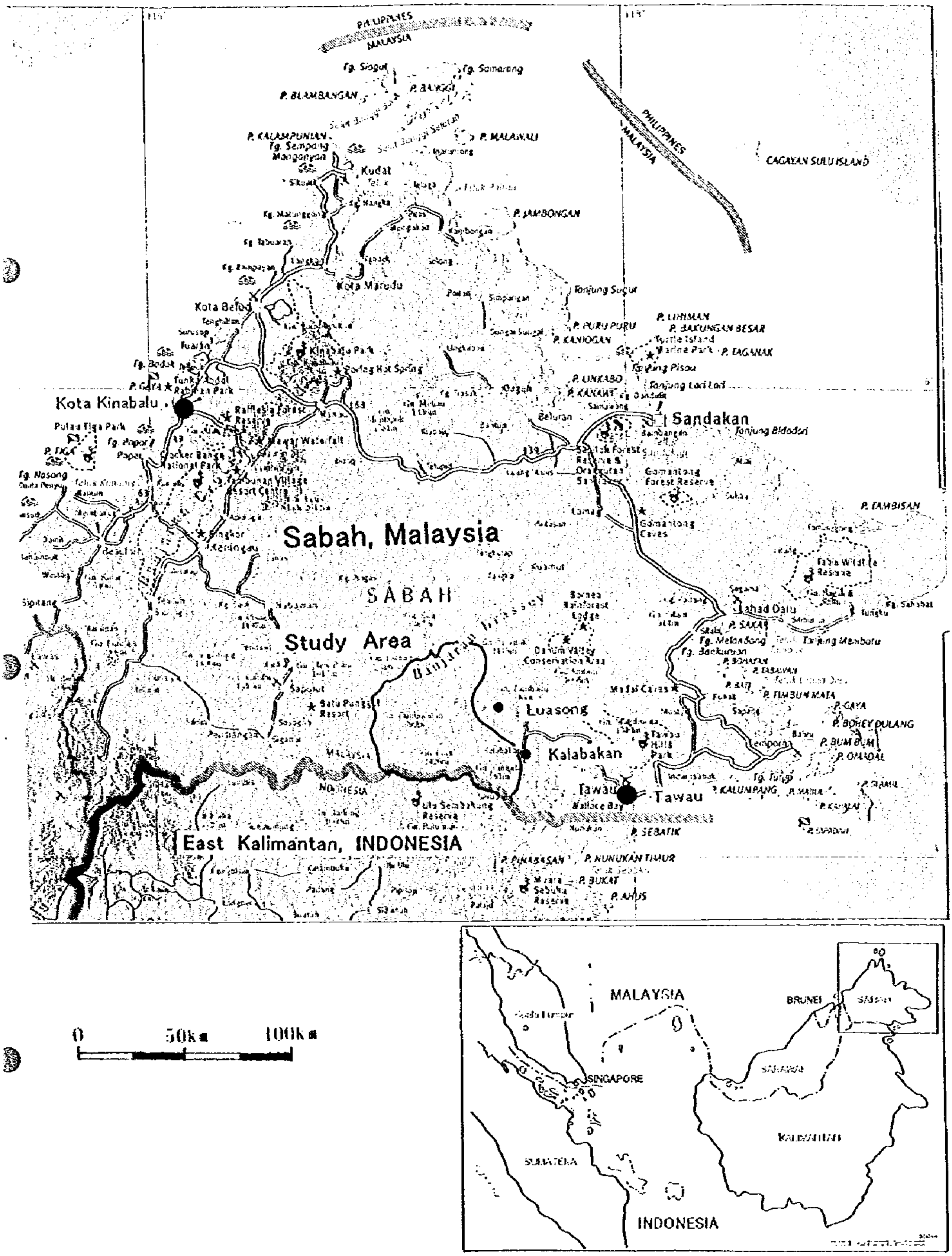
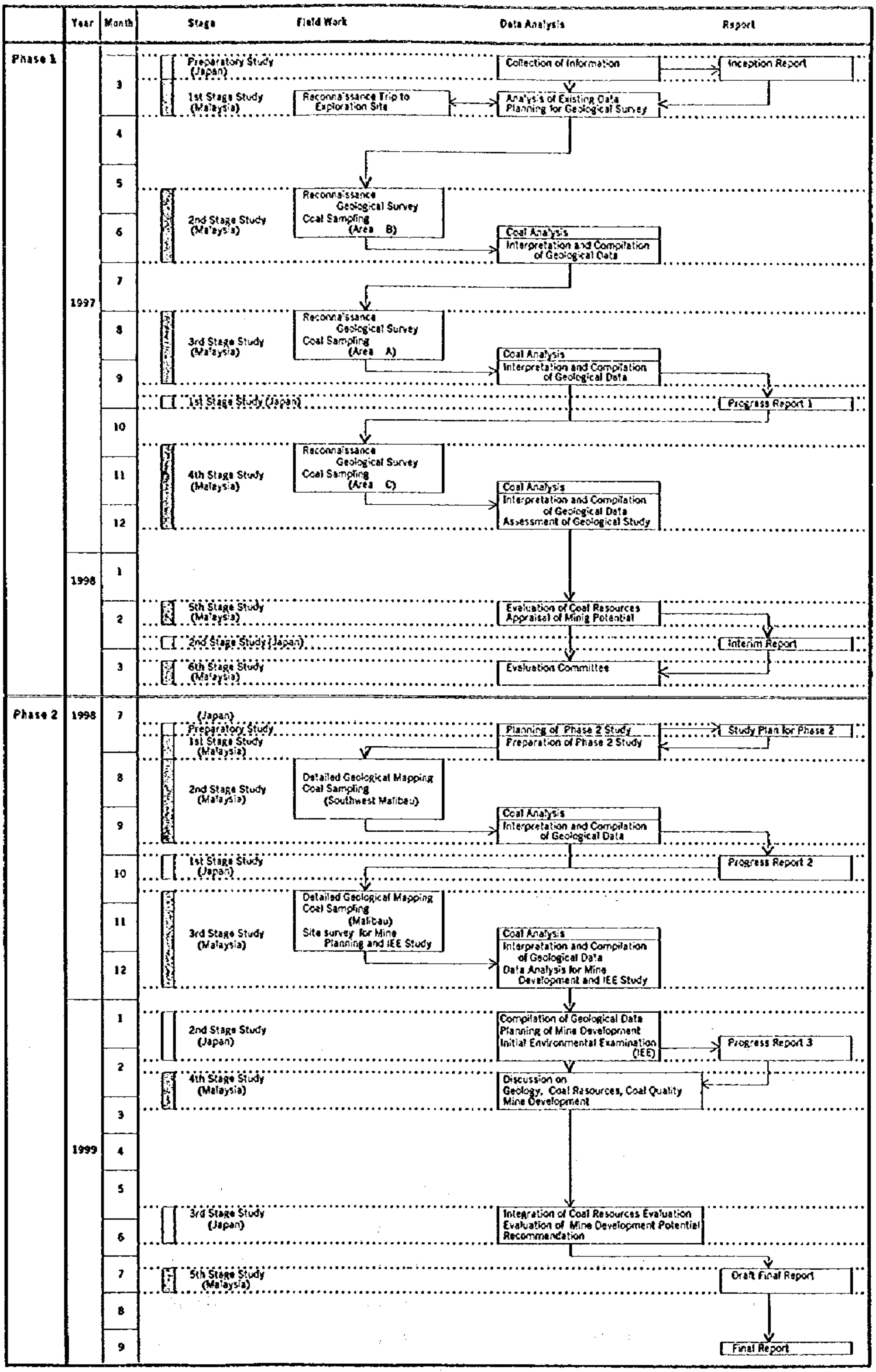


Figure 1-1 Location of Study Area

Figure 1-2 General Flow Chart of the Study



given to indigenous energy utilization.

In the Seventh Malaysia Plan (1996 - 2000) established in 1996, stronger emphasis is given to coal utilization. One of the reason is the concern about long-term sustainability of gas utilization owing to diminishing natural gas reserves. It is suggested that the gas utilization for power generation may be declined after 2000, if further gas reserves are not discovered.

In the Seventh Malaysia Plan, the role of coal is stressed as quoted below :

"In line with efforts to pursue the fuel diversification policy within the least-cost planning, coal will play an increasingly important role during the Plan period. Exploration and assessment of coal resources will be stepped up by the Geological Survey Department and the private sector, particularly in Sabah and Sarawak. The development of known coal deposits is expected to be intensified in view of high demand for coal in electricity generation and cement manufacture. About 90% of the 5.5 million tonnes required annually by the country will be met by import. With improvements in the infrastructure leading to coal deposits, the production of local coal is expected to increase further. Local coal production is expected to increase from 200,000 tonnes in 1995 to 510,000 tonnes by the year 2000, most of which will be used locally."

1.2.2. Coal Demand and Supply

(1) Present Status

Beradai Mine, owned by Global Minerals, is an only operating coal mine in Malaysia and more than 90% of total coal supply is imported as shown below :

Coal Supply in Malaysia (t)

	Domestic	Imported	Total
1994	173,749	1,380,833	1,554,582
1995	114,100	2,003,315	2,117,415
1996	73,747	3,003,294	3,007,041
1997	105,231	2,550,511	2,655,742

In coal export to Malaysia, the maximum exporter is Indonesia followed by Australia. These two countries occupy more than 90% of total imported coal in Malaysia.

Most of the coal in Malaysia are used for power generation and cement manufacture. Broadly speaking, 60% is for power generation and 40% is for cement manufacture.

(2) Future Prospect

Based on the figures in the Seventh Malaysia Plan, the future trend of coal demand in Malaysia has been estimated.

	Power	Cement	Total (1,000 t)
1995	1,570	1,170	2,740
2000	4,410	2,680	7,090

The above-mentioned figures of 4.4 million tonnes for power generation is the assured coal demand after the operation start in the power plants under construction. Afterward, there are plans to construct large scale power plants including IPP between 2001 and 2005. Coal requirement for these new plants exceed 10 million tonnes. Although the time for completion of these plant is uncertain, the possibility of significant increase in coal demand far power generation must be high in near future.

The second oil crisis in late 1970s prompted cement companies to convert fuel used in their plants from oil to coal. By 1988, all plants were using only imported coal or mixing with oil. Demand for cement product is largely affected by the tendency of construction industry, particularly of public undertaking. It is expected that the demand for cement will grow in near future as the recession in Asian countries is being recovered.

With respect to the coal supply, production of Beradai Mine, which is the sole coal producer in Malaysia, stays in a low level and development of new coal mine will not be realized easily and quickly. Therefore, to meet the increasing demand for coal, dependency to imported coal will continue far the moment. As stated in the Seventh Malaysia Plan, it is expected to facilitate the exploration and develop a new coal mine in the near future.

2. Summary of Phase 1 Study

2.1. Study Area

2.1.1. Location and Access

The Study Area is situated in the south-central part of State of Sabah as shown in Figure 1-1. It is bounded by the Indonesian border on the south and lies in an area of latitude 4° 51′ N on the north and longitude 117° 30′ E and 116° 50′ E on the east and west respectively.

The area is accessible by road from Tawau via Luasong or Kalabakan at a distance of about 90 km to the eastern border of the area. Within the area, several routes are passable by vehicle and some of them are being used for log transportation at present. However, most of the previous logging roads branching off from the main roads have been deteriorated and abandoned as soon as logging operations finished.

There is neither village nor inhabitant within the area except a few camps owned by timber companies. Nearest villages to the study area are Kalabakan and Luasong; both are located close to the eastern border of the area. Kalabakan is a base of timber related activities where saw mills and loading facilities to barge are in operation. In Luasong, there is the forestry center operated by Yayasan Sabah (Sabah Foundation).

2.1.2. Topography and Climate

Figure 2-1 shows the topography and drainage system in the area.

The major part of the area, particularly the western part, is hilly and mountainous and mostly covered with the secondary jungle. Several mountain tops exceed 1,000 m with the highest peak of 5,500 ft (1,676 m) in the southwest. The relief becomes gentle and lower toward the southeast and comes to low-lying land in the lower reaches of several rivers. Extensive plantation of oil palm is found in this part.

The drainage system in the area is complex but divided into two main systems as a whole.

The one extends in the major part of the area and comprises several rivers, including Kalabakan, Serudon and Silimpopon Rivers. They flow principally toward the southeast and finally into Cowie Harbour. The other is Kuamut River and its tributaries in the northwestern part of the area. It flows toward the northeast as far as Sulu Sea near Sandakan. A winding range of mountains forms the watershed of the area as shown in Figure 2-1.

According to the meteorological data extracted from the statistics for the past seven years observed at Forestry Center in Luasong, the temperature is invariable throughout the year. A difference of 10℃ between the highest(32℃) and the lowest temperatures(22℃) represents the change in a day. The average annual rainfall is 2,766 mm, however there is a great variation from 2,072 ㎜ in 1991 to 3,920 ㎜ in 1995. Monthly rainfall figures does not indicate any clear distinction between dry and wet seasons. It seems that, however, rainfall in January to April is less and that in October to December is more compared with other months, although it also varies widely in every year.

2.2. Geological Investigation

2.2.1. Previous Work

In early 1900's, geological traverses or reconnaissance trips have been made by several foreign geologists in and around the study area, but their reports are unavailable. Between 1950 and 1952, P. Collenette made a geological investigation on the coal deposits in Silimpopon area. He also carried out a reconnaissance geological survey between 1958 and 1960 in a wide area of south-central part of Sabah, including the present study area.

BHP Minerals has carried out reconnaissance coal exploration inthe major part of south central Sabah, which includes Maliau, Malibau, Luis-Sesui, Serudong and Silimpopon areas, for several years since 1986 under a prospecting licence. Their result indicates a good potential of coal resources in Maliau Basin.

GSD Sabah has started exploration for coal in the study area in 1994 under the Mineral Exploration Programme and the results are given in the respective reports:

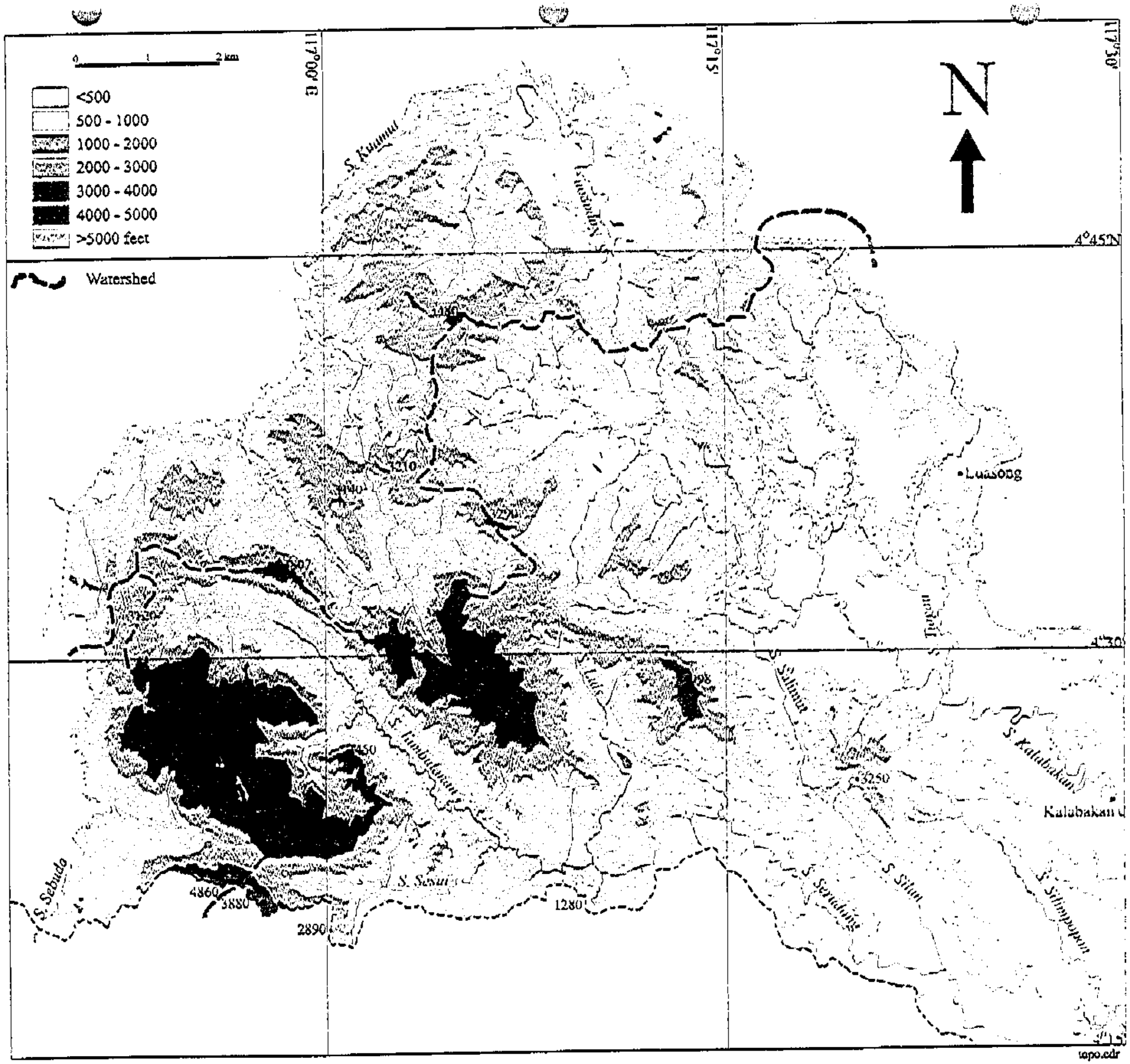


Figure 2-1 Topography and Drainage

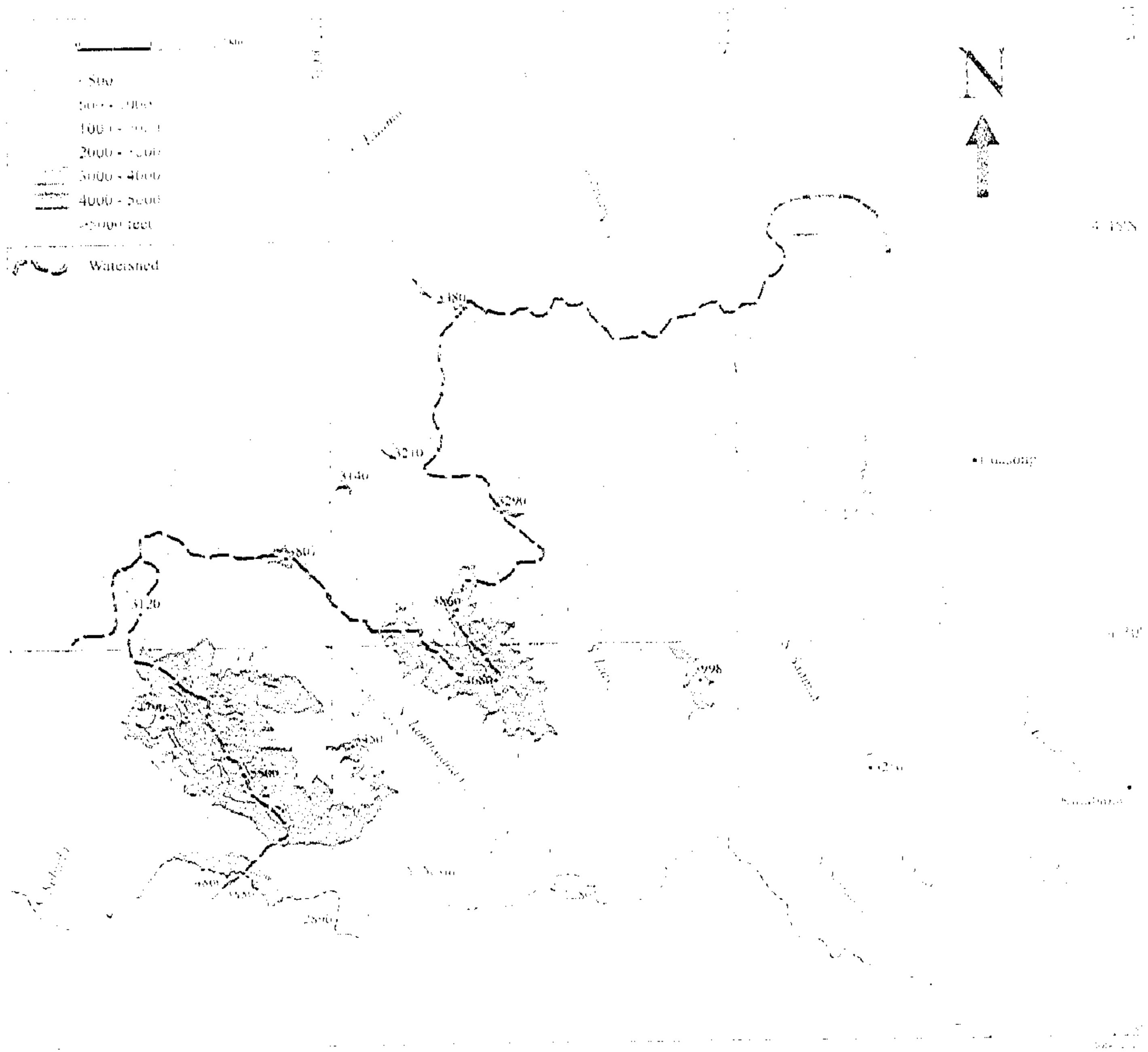


Figure 2-1 Topography and Drainage

All the relevant information in the above reports were examined and used for the present study.

2.2.2. Method of Geological Investigation

In order to investigate whole of the extensive study area within a limited period, surface geological survey was carried out laying emphasis on the areas or zones where the occurrence of coal seam had been expected based on the previous reports.

The study area was divided into following three sub-areas: (approximate size)

Sub-area A : Northeastern part including Malibau area, (800 km^2)

Sub-area B : Southwestern part including Southwest Malibau area, (700 km^2)

Sub-area C : Southeastern part including Silimpopon area, (500 km^2)

Each sub-area was investigated at three separate stages. A base camp was set up in each sub-area and temporary camps were required where investigating sites were unaccessible by vehicle and too far to travel on foot. Representative mapping routes were selected mostly along old logging tracks or streams. Every outcrop along the routes was geologically investigated and at the same time, its location and elevation was surveyed with a compass, tape and hand level. Outcrop positions and survey points were plotted instantly in field mapping sheets together with the observed geological data.

All the coal outcrops were logged lithologically and numbered except thin seams or of poor quality like coaly shale. Forty five (45) coal samples were collected from outcrops and analyzed at the coal laboratory in GSD Sarawak. During the field work in sub-area C, an outcrop of Queen Seam near the old mine site was investigated and sampled.

The advantage of the above-mentioned mapping method is that a geological route map is prepared and available in the field and the stratigraphic position of each outcrop can be understood by drawing a cross section along the route. This method is effective particularly for the coal field like the study area where a large number of coal seams are present with steep dips.

The location and the number of the mapping routes are shown in Figure 2-2.

2.3. Coal Seam Occurrence

2.3.1. General

In the present study, the term of "coal zone" has been used for such a stratigraphic unit as coal seams occur in some degree of frequency, although not a clear definition. Because the field investigation gave priority on coal zone, the whole sequence of the Tanjong Formation was not observed. Therefore, only the coal zone in each sub-area is the subject of the study in terms of stratigraphy and correlation.

The coal zones which extend longer in strike direction with considerable thickness are recognized in four areas, namely, Malibau, Southwest Malibau, Sesui West and Silimpopon areas. The main geological features including distribution of coal zone are summarized in Figure 2-3.

The following is a summary of the modes of occurrence of coal seams in each area based on the findings in the field work of Phase 1.

2.3.2. Malibau Area

The coal zone extends over 12 km along the strike direction with the thickness ranging from 800 m in the western part and 1,150 m in the central to eastern part.

Number and stratigraphic level of coal seams also varies in each part of the area. In the western part, only four coal seams exist in the lower section of the coal zone. However, ten coal seams were observed in the central and the eastern parts at different levels of coal zone, namely, in the middle to lower sections in the central part and in the middle to upper sections in the eastern part.

The thickness of coal seams are generally thin. Coal outcrops of more than 1 m thick were observed only at several locations. The outcrop at the southeastern end of the area (HK012) has the maximum thickness of 1.50 m, but it contains many partings.

The geological structure of the area is relatively simple. The coal seams have E-W trending

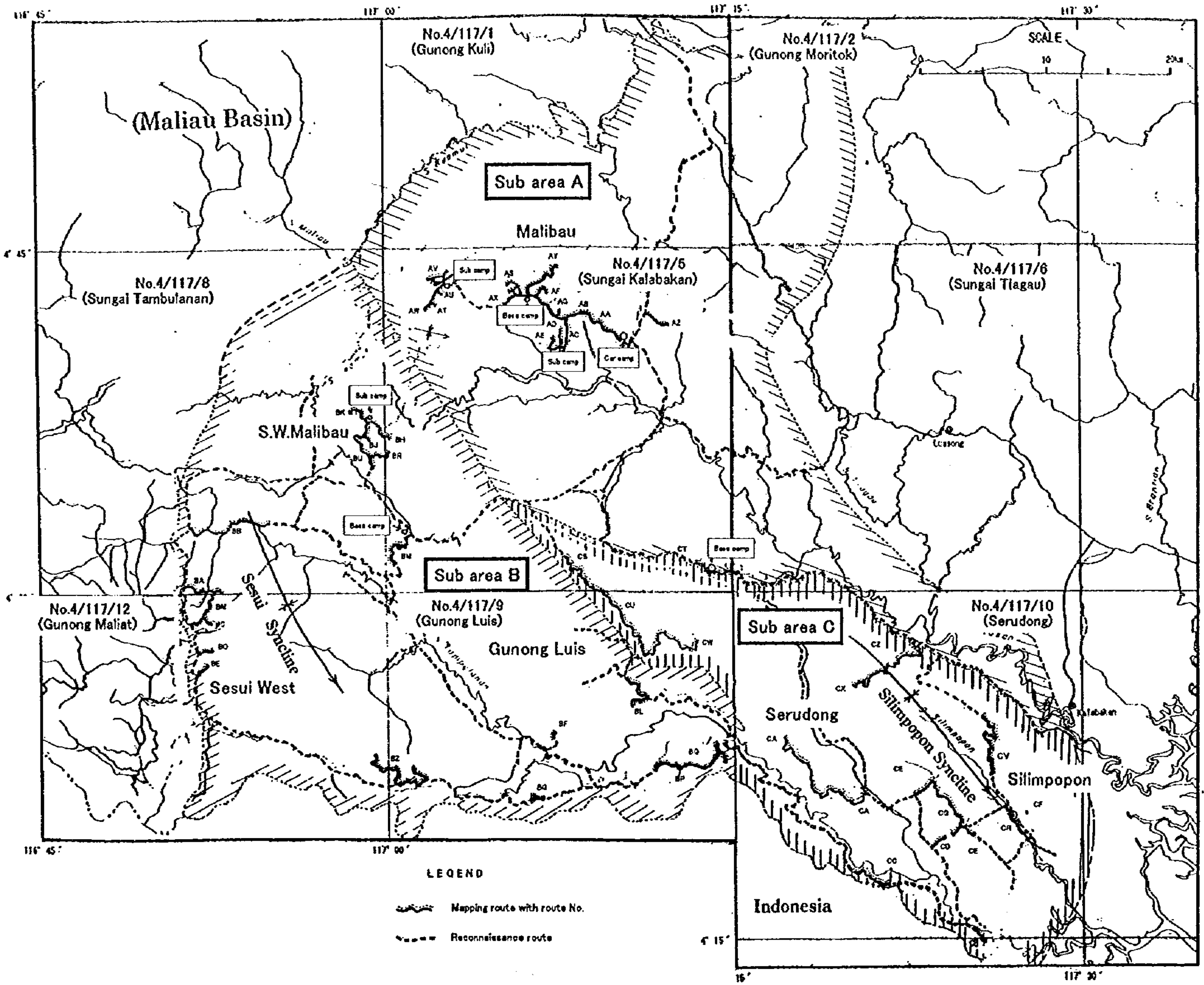


Figure 2-2 Location of Mapping Routes

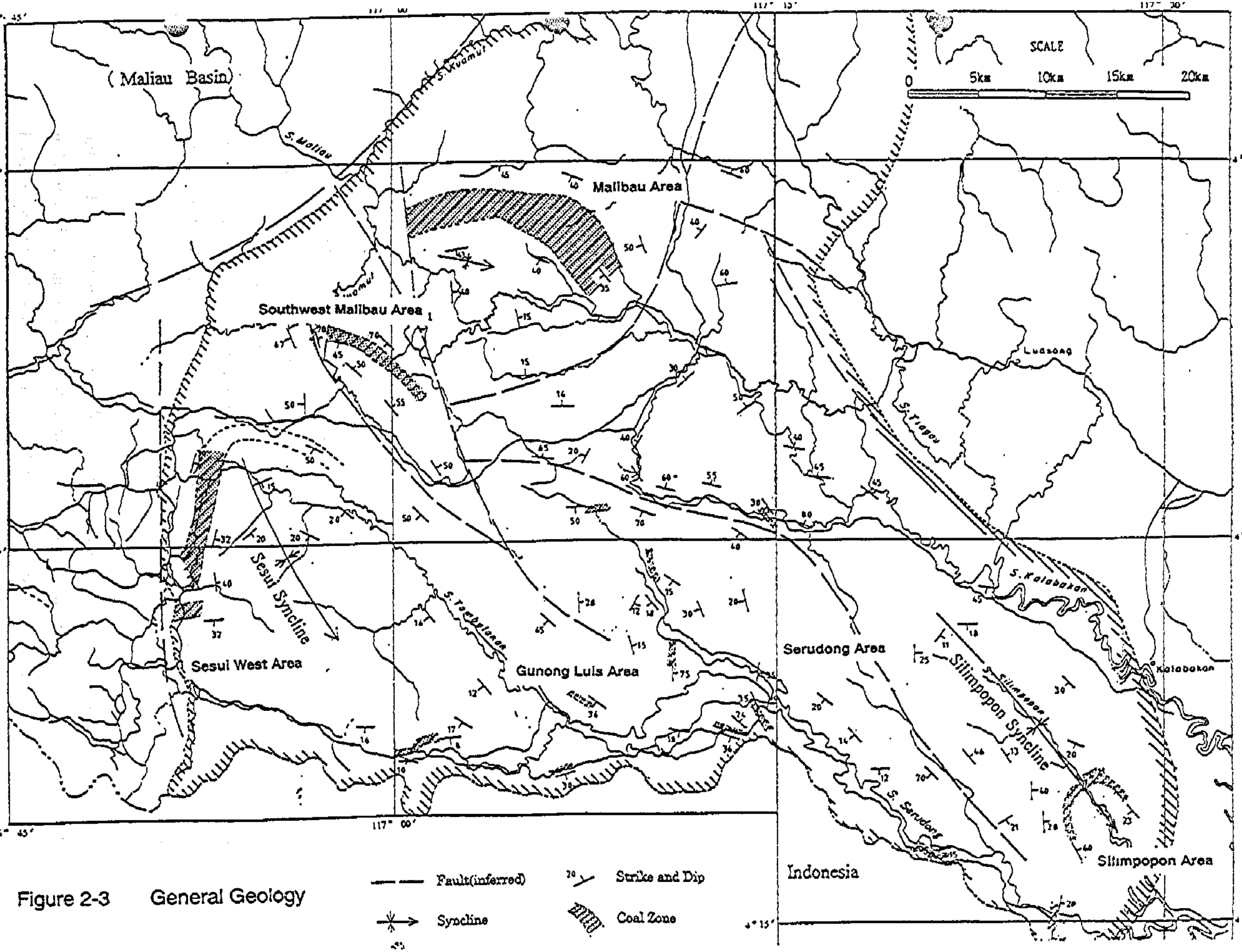


Figure 2-3 General Geology

strike in general, turning gradually to NW-SE at the eastern part and to ENE-WSW at the western part. The dip of coal seams ranges from 25 to 50 degrees toward the south, 35 degrees on an average. No significant disturbance in geological structure has been found in the field.

2.3.3. Southwest Malibau Area

The coal zone of the area has the thickness of 330 m and extends over 4.5 km in the strike direction with possible extension of 1 km each to both NW and SE sides. The coal seams are observed at six stratigraphic levels in the western part of the area, while they increase to nine in the eastern part.

The coal seams in the area are much thicker than those of Malibau area. More than half of the investigated outcrops exceed 1 m in thickness. The maximum thickness is 4.86 m at the western end of the observed coal zone which, however, appears to be thinning toward the east.

The coal seams extend with a general strike of NW-SE direction, slightly turning to the west at the western end of the coal zone. They incline very steeply to the south in general, but nearly vertical or northerly dipping at some places in the eastern part.

2.3.4. Silimpopon Area

Out of several coal seams in the area, only the Queen Seam has a mineable thickness. There was a coal mine which produced about 1.5 million tons of coal from the Queen Seam and it was closed in 1932 after 27 years operation. Nine boreholes were sunk in early 1900's to explore the Queen Seam and geological investigation in the area was carried out by P. Collenette around 1950. The following explanation is based on the report of the above investigation as well as the field mapping in the present study.

The outcrop of the Queen Seam has been traced for the distance of about 7 km from the north to the southeast. The Seam has a thickness of more than 1.6 m at the northern part but it thins and deteriorates toward the southeast. In the western part, no outcrop was observed due to a lack of exposure. However, three thin coal outcrops at the southwestern part may suggest a same thinning trend as in the eastern part.

The geological structure in the area is dominated by a broad syncline, with an axis plunging to the southeast. The coal seam inclines toward the axis at 10 to 25 degrees.

2.3.5. Other Areas

Besides the above mentioned areas, about 20 routes were traversed and a large number of coal outcrops were observed. Most of them, however, are thin and exist in a limited extent. The following is a brief explanation of the coal seam occurrence in these routes.

(1) Sesui West Area

The area is situated in the western flank of the Sesui Syncline and close to the western border of the study area. Several routes were surveyed and a coal zone of 600 to 800 m thick appears to extend for the distance of about 8 km in N-S direction. Most of the coal seams in this coal zone are very thin or deteriorated to carbonaceous shale.

(2) Gunong Luis Area

A large number of coal outcrops were observed along the several routes in and adjacent to the Gunong Luis map sheet, however, all of them are very thin or deteriorated to carbonaceous shale. Even coal is thicken locally , they are not persistent in thickness and show lenticular occurrence.

(3) Serudong Area

Several routes were investigated in and adjacent to the Serudong map sheet. All of the coal outcrops observed in this area are thin and dirty with many partings except for the Queen Seam.

2.4. Estimate of Coal Resources

2.4.1. Malibau and Southwest Malibau Areas

An attempt was made to estimate the geological coal resources of Malibau and Southwest Malibau Areas, based on the result of investigation in Phase 1. The estimate was made basically in accordance with the GSD's Reserve/Resource Classification System.

The following are the criteria adopted for coal resource estimate in the present study :

(a) Resource class

The present exploration is regarded as "prospecting stage" of geological study according to the definitions of the GSD system. Consequently, estimated quantity is classified as "Inferred Resources (333)".

(b) Limiting factors

The following factors were adopted for resource estimate in this study :
Minimum coal thickness : 0.6 m (excluding partings)
Maximum distance in dip direction from the surface along the seam : 500 m
Specific Gravity of coal : 1.3

(c) Method of estimate

Area of estimate is divided into four blocks in Malibau and three blocks in Southwest Malibau areas. In each block, the average coal thickness of individual coal seams are calculated by averaging measured thickness at outcrops within the block and an accumulated coal thickness of individual coal seams is used for tonnage calculation.

Resource of each block is obtained with the following formula :

Resource (t) = length of block (m) x 500 (m) x accumulated thickness (m) x 1.3

Figures 2-9-1 and 2-9-2 show the details of resource estimate of individual blocks in Malibau and Southwest Malibau respectively and the estimated resources are summarized in Table 2-1. In Malibau area, the total resources are 25 million tonnes, most of which are of coal seams less than 1 m thick. In Southwest Malibau area, the coal resources amount to 26 million tonnes and major part of them are of coal seams more than 1 m thick.

2.4.2. Silimpopon Area

The coal resources of the Queen Seam in Silimpopon area have not been estimated in the present study, because the estimated reserves have been given in the previous report

Table 2-1 COAL RESOURCES (Phase 1)

(MALIBAU AREA)

BLOCK	A	B	C	D	TOTAL
Total coal thickness	2.60 m	* 2.35 m	2.10 m	4.70 m	
Coal seams (>0.6m)	4 seams	uncertain	3 seams	6 seams	
				MC-1 0.60 m	
	MW-1 0.60 m			MC-2 0.90 m	
	MW-2 0.70 m			MC-3 1.20 m	
	MW-3 0.70 m		MC-4 0.60 m	MC-4 0.60 m	
	MW-4 0.60 m			MC-5 0.60 m	
			MC-6 0.60 m		
			MC-7 0.90 m	MC-7 0.80 m	
Strike length	5.0 km	2.5 km	4.0 km	2.5 km	
Dip length	500 m	500 m	500 m	500 m	
Specific gravity	1.3	1.3	1.3	1.3	
Resources (mil.tonnes)	8.450	3.819	5.460	7.638	25.367

*: Mean thickness of A and C

(SOUTHWEST MALIBAU AREA)

BLOCK	A	B	C	TOTAL
Total coal thickness	6.00 m	6.50 m	6.10 m	
Coal seams (>0.6m)	5 seams	7 seams	6 seams	
		SW-1 1.00 m	SW-1 1.60 m	
	SW-2 1.40 m	SW-2 1.00 m	SW-2 0.80 m	
	SW-3 2.30 m	SW-3 1.00 m		
		SW-4 1.10 m	SW-4 1.10 m	
	SW-5 0.60 m	SW-5 0.70 m	SW-5 1.10 m	
	SW-6 0.60 m	SW-6 0.60 m	SW-6 0.60 m	
	SW-7 1.10 m	SW-7 1.10 m	SW-7 0.90 m	
Strike length	2.25 km	2.0 km	2.25 km	
Dip length	500 m	500 m	500 m	
Specific gravity	1.3	1.3	1.3	
Resources (mil.tonnes)	8.775	8.450	8.921	26.146

(P.Collenette, 1954) and no additional exploration has been done since then.
The coal reserves given in the above report are as follows :

Table 2-2 Coal Reserves of Queen Seam (P.Collenette, 1954)

	Remaining Reserves	Coal Available for Mining
Measured	4,851,000	2,739,000
Indicated	1,496,000	1,472,000
Inferred	7,745,000	6,403,000
Total	14,092,000	10,614,000

2.5. Evaluation of Coal Quality

Forty five (45) coal samples were collected from outcrops and analyzed at the coal laboratory of GSD Sarawak. Analytical items are Proximate Analysis, Gross Calorific Value, Total Sulphur, Ultimate Analysis (C,H,N,) and Free Swelling Index (FSI).

The coal in the area has the characteristics in quality of low to medium ash, high calorific value, high volatile, low nitrogen and widely ranging sulfur. These are suitable quality as steaming coal in general. Although undesirable quality values such as high sulfur and high ash are found in some samples, they seem to be improved in some degree by selecting coal seams in the main coal deposits.

2.6. Conclusion of Phase 1 Study

2.6.1. Geological Assessment

During the field work programme of Phase 1 study, a large number of coal outcrops were observed in the study area. All of the collected data as well as existing information were examined and evaluated from the viewpoints of geological condition, coal reserves, coal quality and mineability.

As a result, the following three areas, namely, Malibau, Southwest Malibau, and

Silimpopon areas, have been identified as the areas with some potential for coal resource development. In other area, almost all the coal seams observed at outcrops are thin and exist in a limited extent, therefore, have no mining possibility.

2.6.2. Mining Potential

The following is a very preliminary consideration on mining potential of the coal seams in the above three areas from the technical point of view :

(1) Each area has different characteristics in mining condition, namely, thin coal seams with moderate to steep dip in Malibau, thicker coal seams with very steep dip in Southwest Malibau, and a moderately thick coal seam with gentle dip in Silimpopon. Suitable mining methods should be selected for different mining condition in each area.

(2) Open cut mining method is probably not applicable to the coal seams in such topographic and geological conditions as in these areas. With regard to the underground mining, conventional mining methods such as longwall mining or room and pillar mining, can be applied to the coal seam with gentle dip. To the steeply dipping coal seam, a step-cut mining is to be studied for example, which has been experienced in some coal mines in Japan with similar conditions. These are not fully mechanized system and an advanced technical expertise is not required.

(3) In consideration of the magnitude of coal reserves and geological conditions, an appropriate production scale of the mine will be small, for example, 100 to 200 thousand tonnes per year, which makes the capital investments minimized.

(4) Judging from the result of coal analysis, the coal in the area can be used as steaming coal for various purposes, including power generation, cement manufacture, and any other industries.

(5) The possible route and means of transportation of product coal is as follows, in the case of exporting to outside of Sabah :

Mine site — (truck) — Kalabakan — (barge) — Tawau — (barge or vessel) —
— Consumers

(6) The possible impacts on surrounding environment will be minimal by operation of small scale underground mines.

3. Procedure of Phase 2 Study

3.1. General

Based on the result of Phase 1 study, implementation of Phase 2 study was decided at the Evaluation Committee Meeting held at the end of Phase 1. The main points of the plan were as follows :

(1) Study areas and their approximate size (see Figure 3-1)

(a) Malibau area - 78 km²
(b) Southwest Malibau area - 26 km²
(c) Silimpopon area - 30 km²

(2) Purpose and Scope of the study

The purpose of Phase 2 study is to make geological assessment and evaluate the mine development potential of the coal resources in the selected areas. The scope of Phase 2 study included the following works to obtain the basic data for this purpose : detailed geological mapping, preliminary mine planning, and initial environmental examination. Detailed items of the study have been stated previously in 1.1.2. Schedule of the study is shown in Figure 1-2 together with that of Phase 1.

3.2. Field Work Programme

3.2.1. Photogrammetric Mapping

Since Phase 2 study requires higher accuracy than Phase 1, new topographic maps on a scale of 1:10,000 were prepared for Malibau and Southwest Malibau areas as shown in Figure 3-2. The maps with 10 m contour intervals were produced from the latest aerial photographs on a scale of 1:25,000 provided by GSD covering areas of about 100 km².

3.2.2. Detailed Geological Mapping

Geological mapping in Phase 2 aimed at improving geological assurance of coal seam data to a level which upgrades the resource class to "Indicated" category and is sufficient for

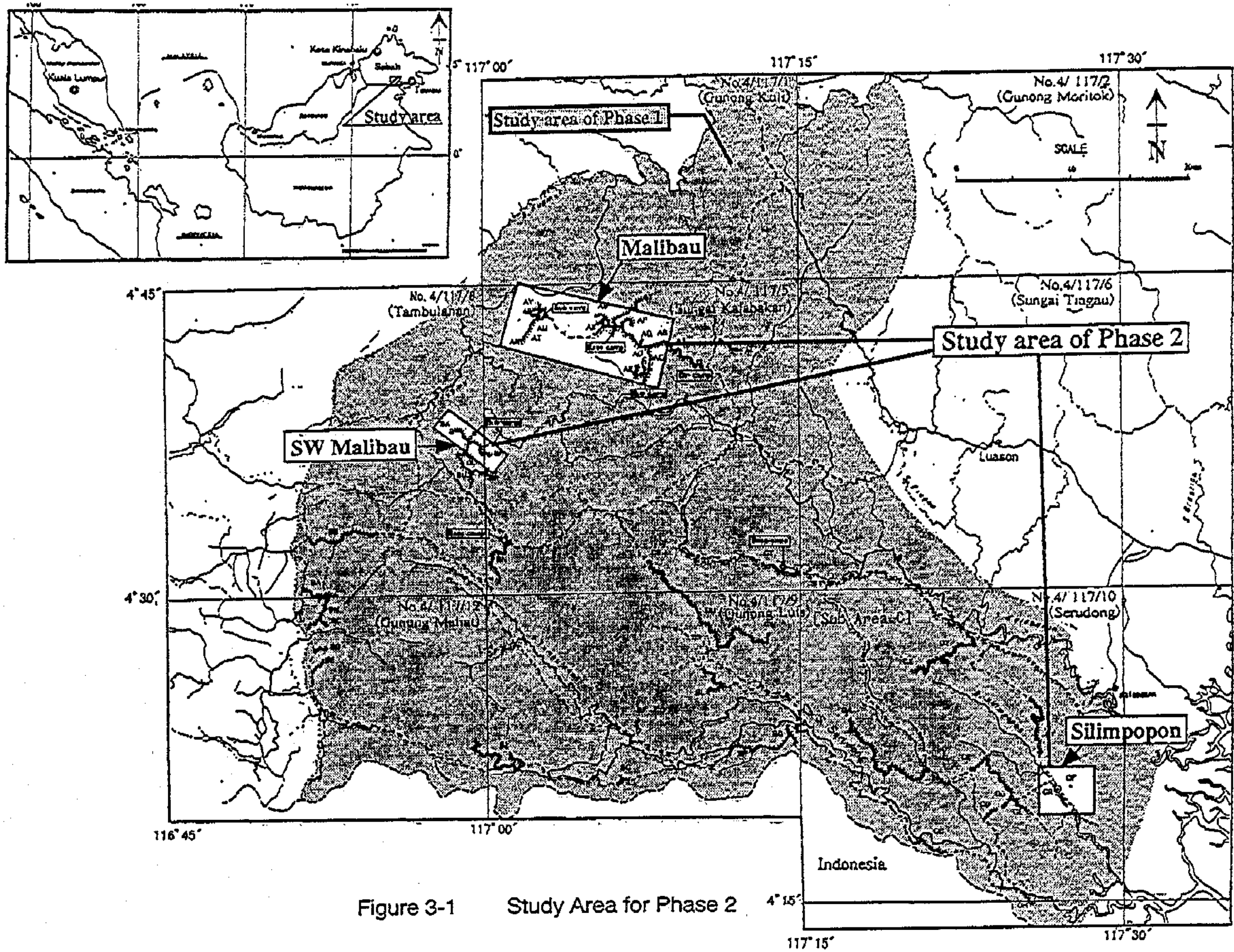


Figure 3-1 Study Area for Phase 2

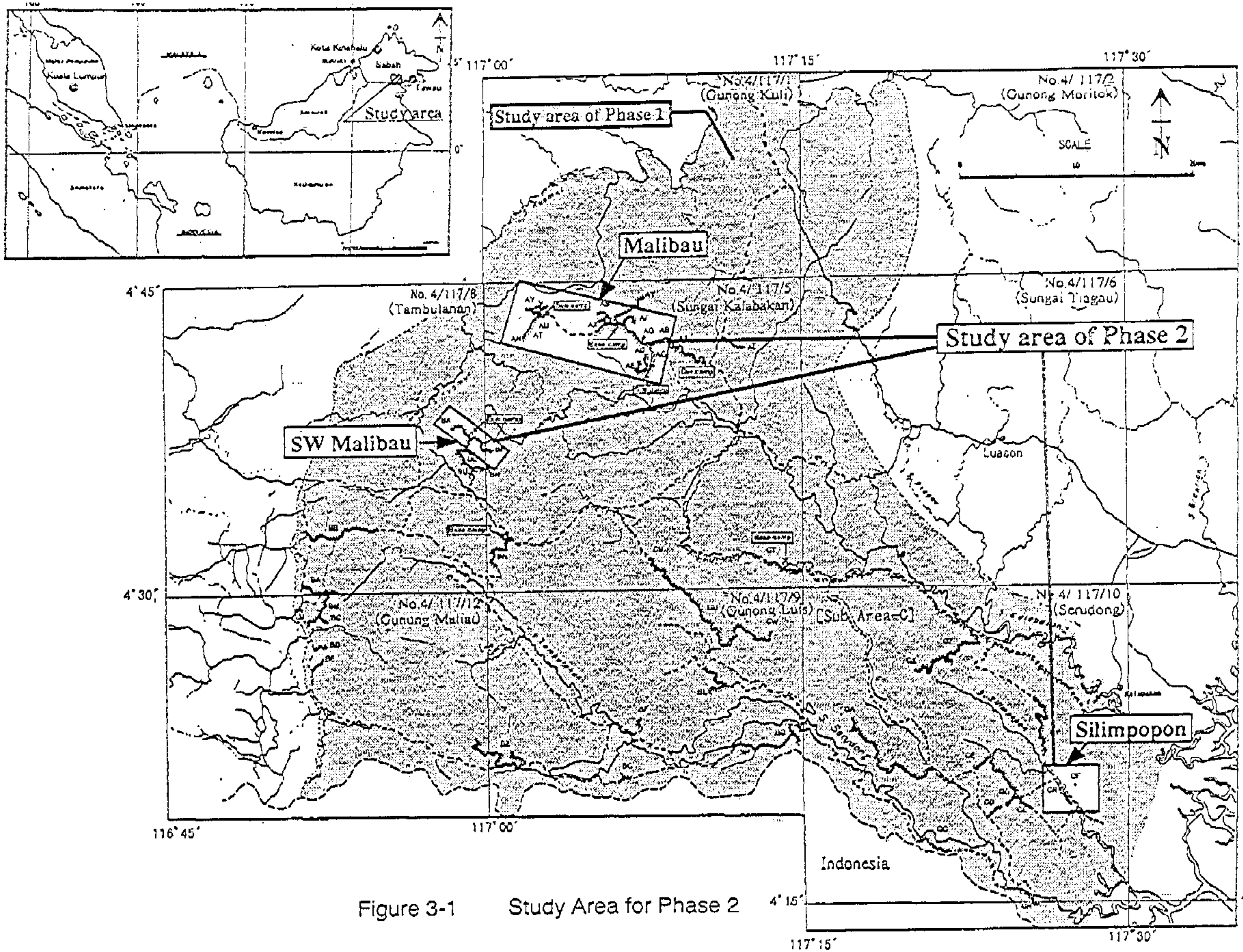
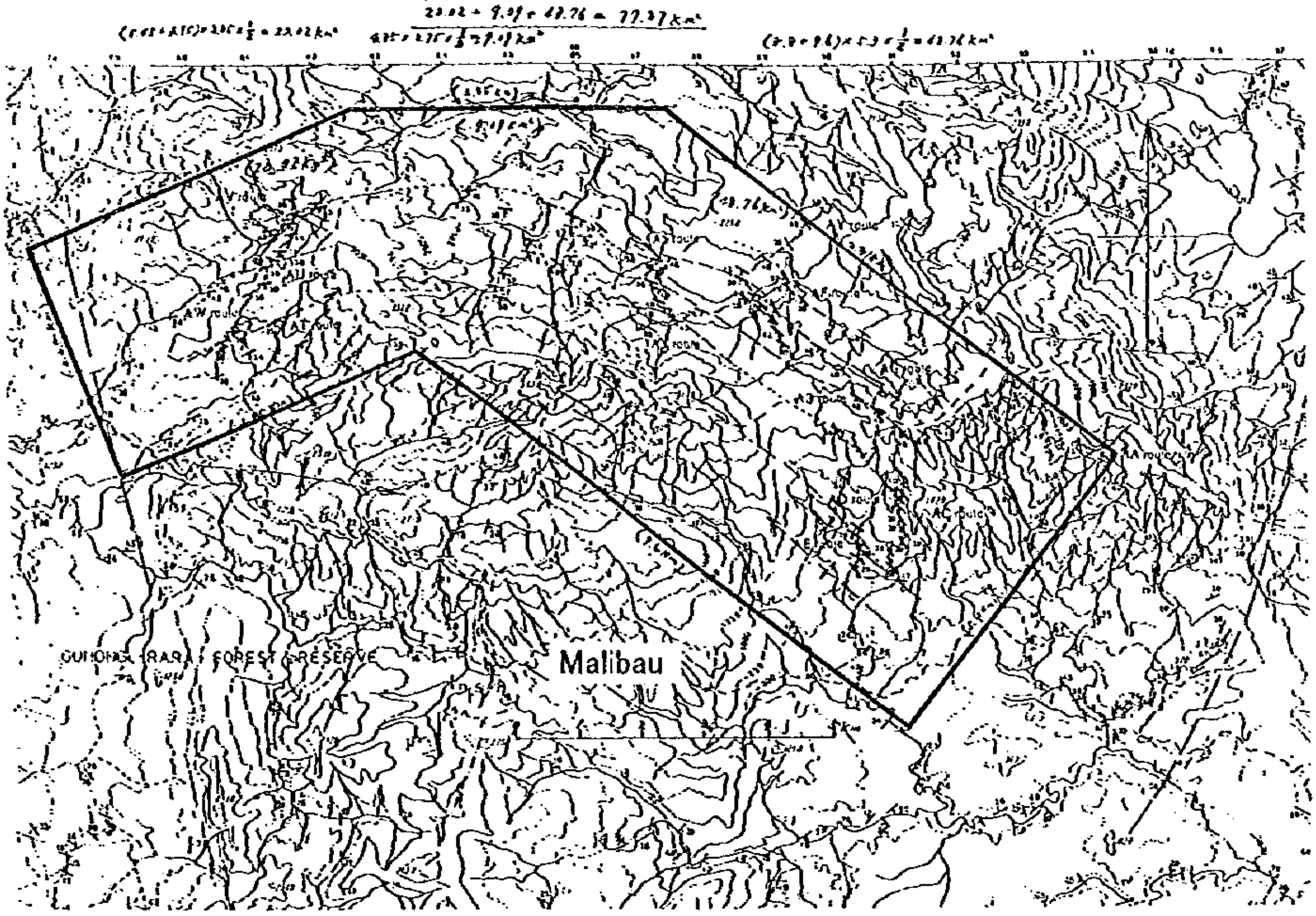
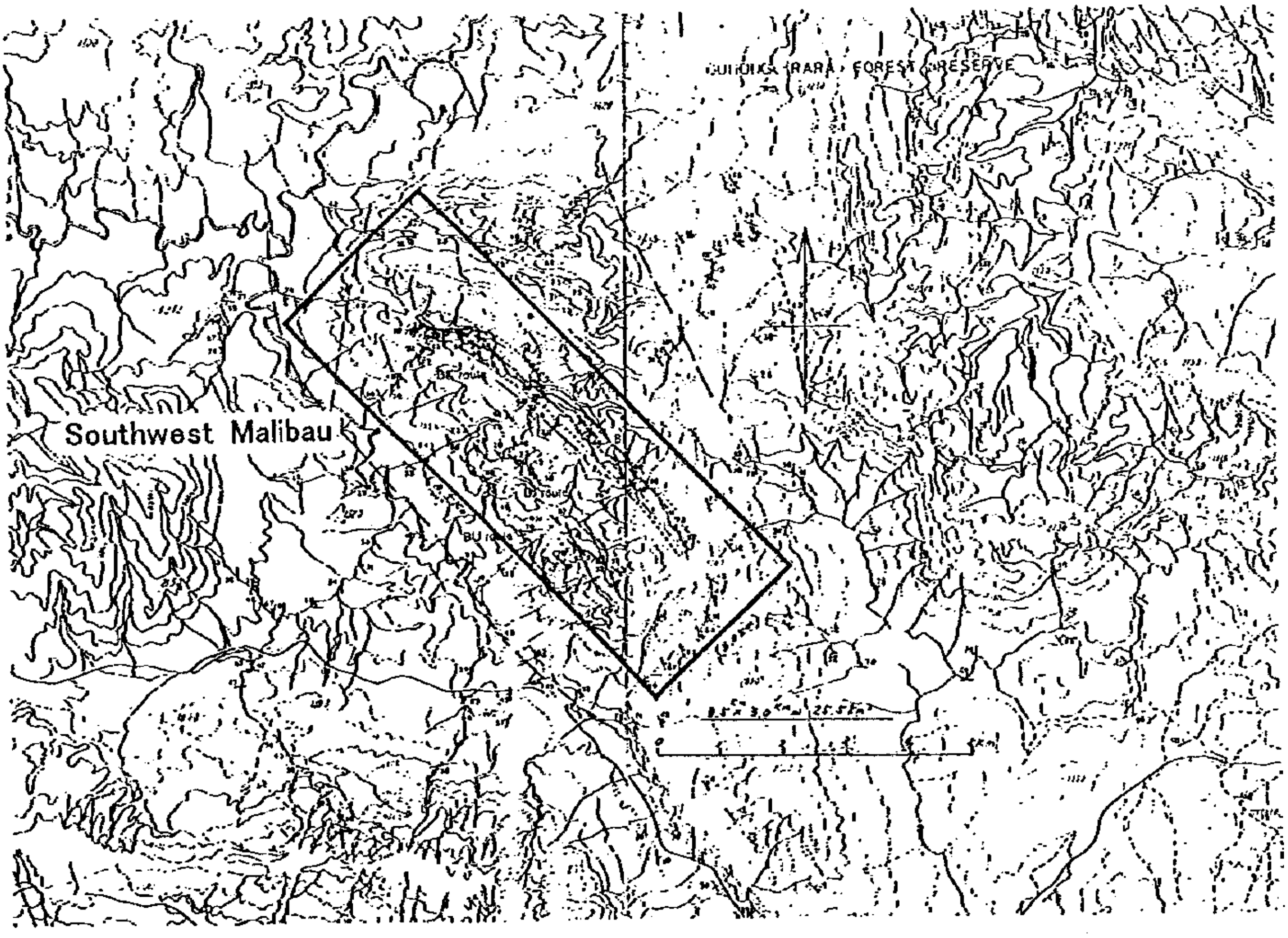
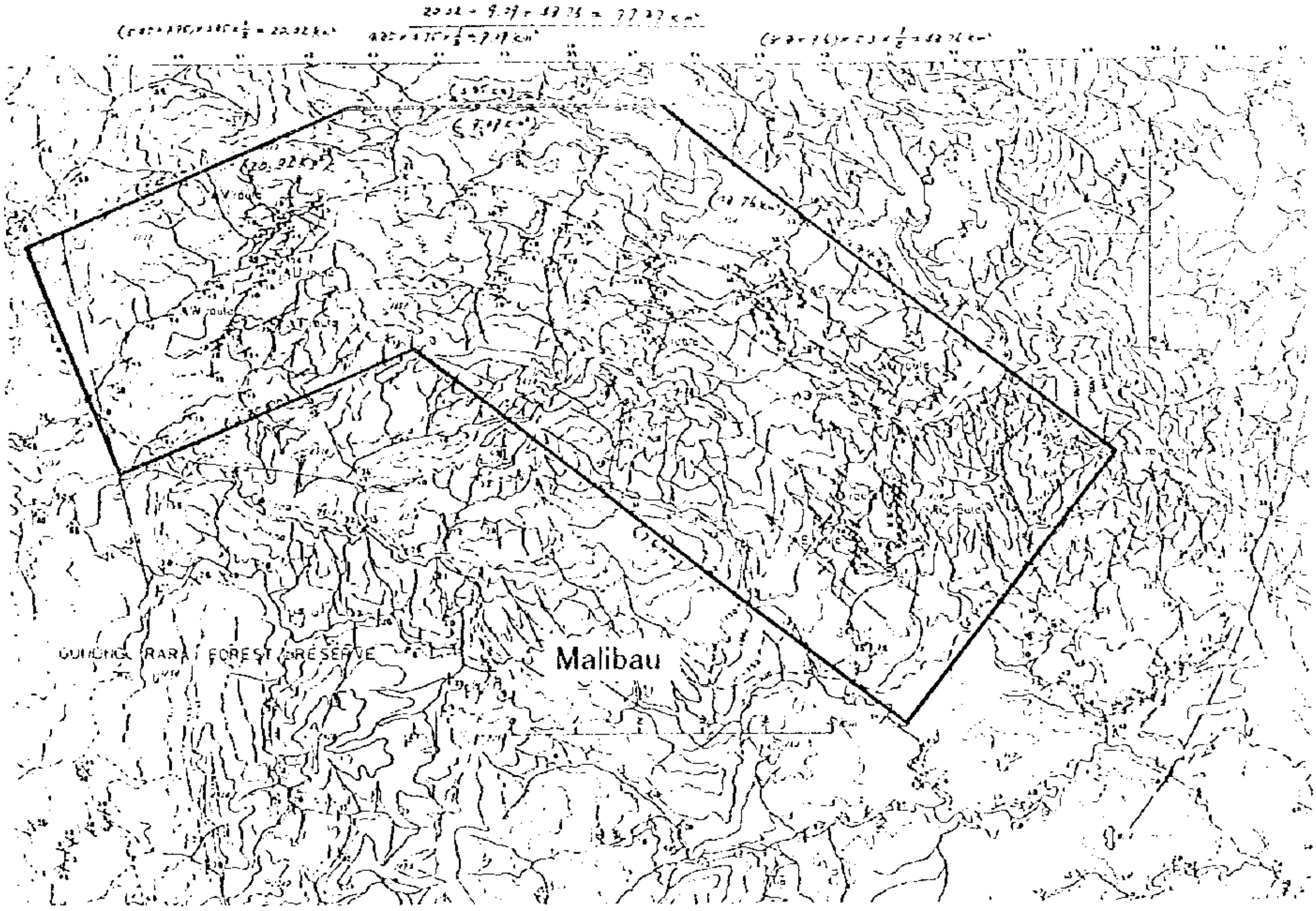


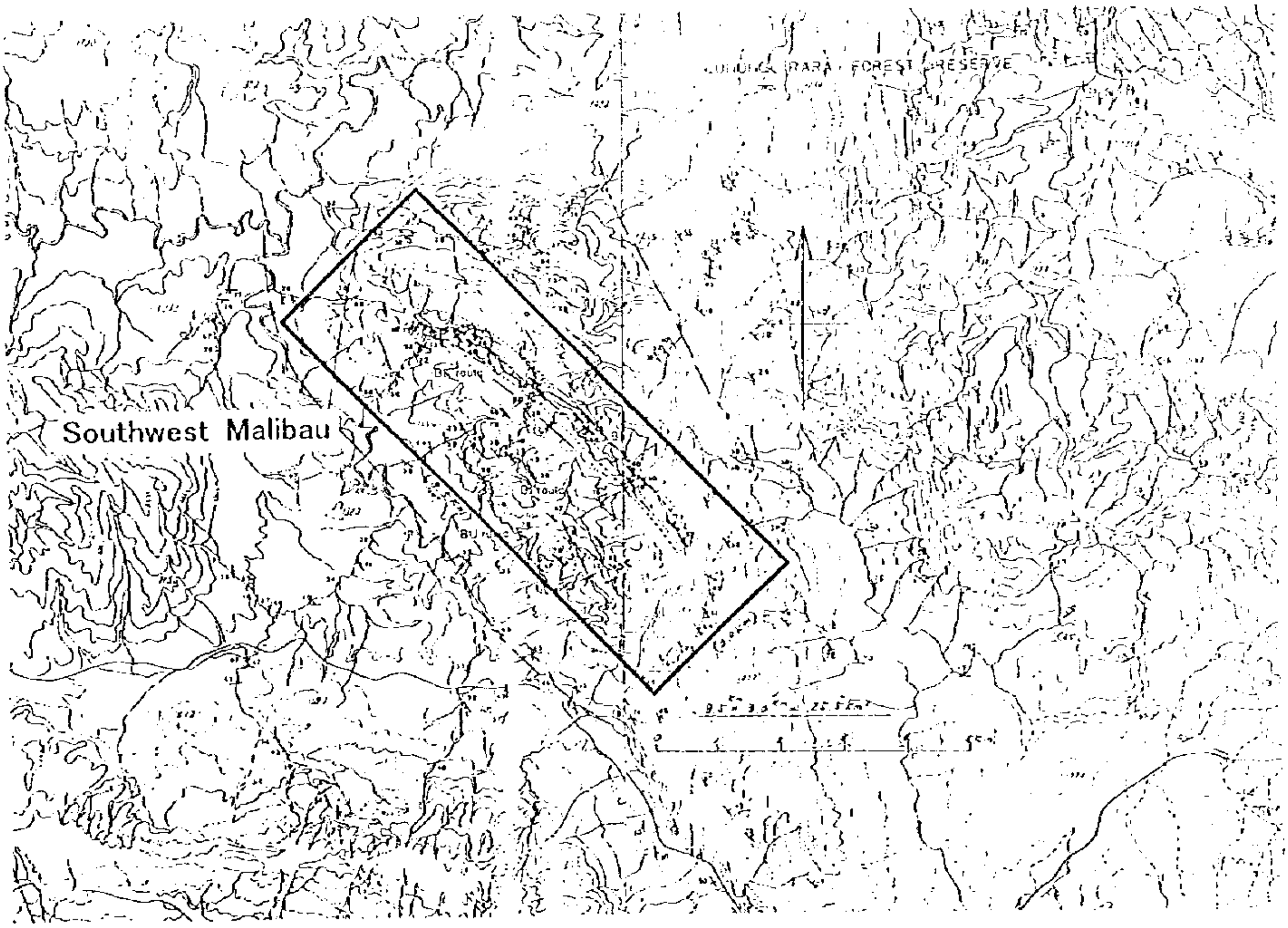
Figure 3-1 Study Area for Phase 2





3- 3 Figure 3-2 Area of Photogrammetric Mappin





3- 3 Figure 3-2 Area of Photogrammetric Mappin making a preliminary mine plan.

During the field work in Phase 2, emphasis was laid on to investigate the coal outcrops as many as possible in unexplored part in Phase 1 and to trace the relatively thick coal seams as long as possible along their expected outcrop lines, so that the correlation and continuity of individual coal seams could be confirmed at the required level of assurance.

3.2.3. Coal Sampling and Analysis

Based on the result of quality evaluation in Phase 1, some kinds of analyses to evaluate the suitability as steaming coal were carried out on selected samples, in addition to general analytical items in Phase 1 as shown below :

① All samples : Proximate analysis, Calorific value, Total sulfur, Ultimate analysis, Free swelling index (FSI)

② Selected samples : Hardgrove grindability index (HGI), Ash fusion temperature, Ash analysis (SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, SO_3, P_2O_5, TiO_2, MnO)

The number of samples in each area is as follows :

	Malibau	SW-Malibau	Silimpopon	Total
Sample ①	15	25	1	41
Sample ②	7	7	1	15

Analysis of sample ① was done at coal laboratory in GSD Sarawak, while analysis of sample ② was done in Japan. Selected samples were homogeneously divided into halves, sample ① and ②, and each of them were sent to Sarawak and Japan respectively.

4. Coal Seams in Study Area

4.1. Malibau Area

4.1.1. Mode of Occurrence

Figure 4-1 illustrates the correlation of coal seams with representative stratigraphic columns of coal zone. By comparing relative position and elevation of neighboring outcrops, continuity of each outcrops has been inferred, and then correlation of coal seams has been established throughout the area, taking their stratigraphic position into account. Continuity of each outcrop is indicated by connecting with broken lines..

As shown in the above-mentioned figures, relatively long continuity is recognized in six coal seams, which have been named MA to MF from the bottom to the top. Other coal seams that exist between these six seams are less continuous or show sporadic mode of occurrence.

The coal seam condition of Malibau area is summarized as follows :

(1) There are a large number of coal seams in a widely extended coal zone. Among them, six coal seams which have been named MA to MF Seams keep their continuity in relatively long distance ranging from 5.7 km in MD seam to 0.6 km in MA seam. Other coal seams are less continuous or occur sporadically.

(2) The coal seams are generally thin. Among 130 coal outcrops observed in Phase 1 and Phase 2, only 12 outcrops exceed 1 m in seam thickness. The thickest outcrop is 1.52 m of MB seam including partings. It seems that thicker seams contain more partings like MB seam which is more than 1 m thick at four outcrops but their average coal thickness excluding partings is 0.89 m. Regarding coal thickness, only six outcrops exceed 1 m in the area.

4.1.2. Geological Structure

Geological structure of the area is relatively stable. The coal seams extend in the shape of crescent, changing their strikes from NW-SE at the eastern part to WSW-ENE at the western part. The dip of the coal seams range from 30 to 55 degrees toward the south, 40 degrees on the average. Any structural disturbance was not observed in the field except at the southeastern corner where a faulting was inferred accompanied by a synclinal structure, but it does not extend to the main part of the coal zone.

4.2. Southwest Malibau Area

4.2.1. Mode of Occurrence

The correlation of coal seams are shown in Figure 4-2. The coal seam condition of Southwest Malibau area is summarized as follows :

(1) A total of 11 coal seams exist in the area and they are classified into six seam groups, namely, SA to SF from the bottom to the top. Both the number of coal seams and the thickness of coal zone increase to the east. The longest continuous extent is 3.5 km in SE1 Seam at the western part.

(2) Compared with Malibau area, the extent and the thickness of the coal zone in the area is much smaller, while the thickness of coal seams contained in the coal zone is much greater. The average thickness of individual coal seams are mostly more than 1 m and great thickness of more than 4 m are found in SB1 and SE1 Seams. However, the coal seams in the area are considerably variable in their thickness. Although SC Group shows relatively constant thickness, they are as thin as about 1 m.

4.2.2. Geological Structure

The coal seams extend in NW-SE direction with very steep dip to the southwest, nearly vertical or dipping in the opposite direction at some places in the eastern part.

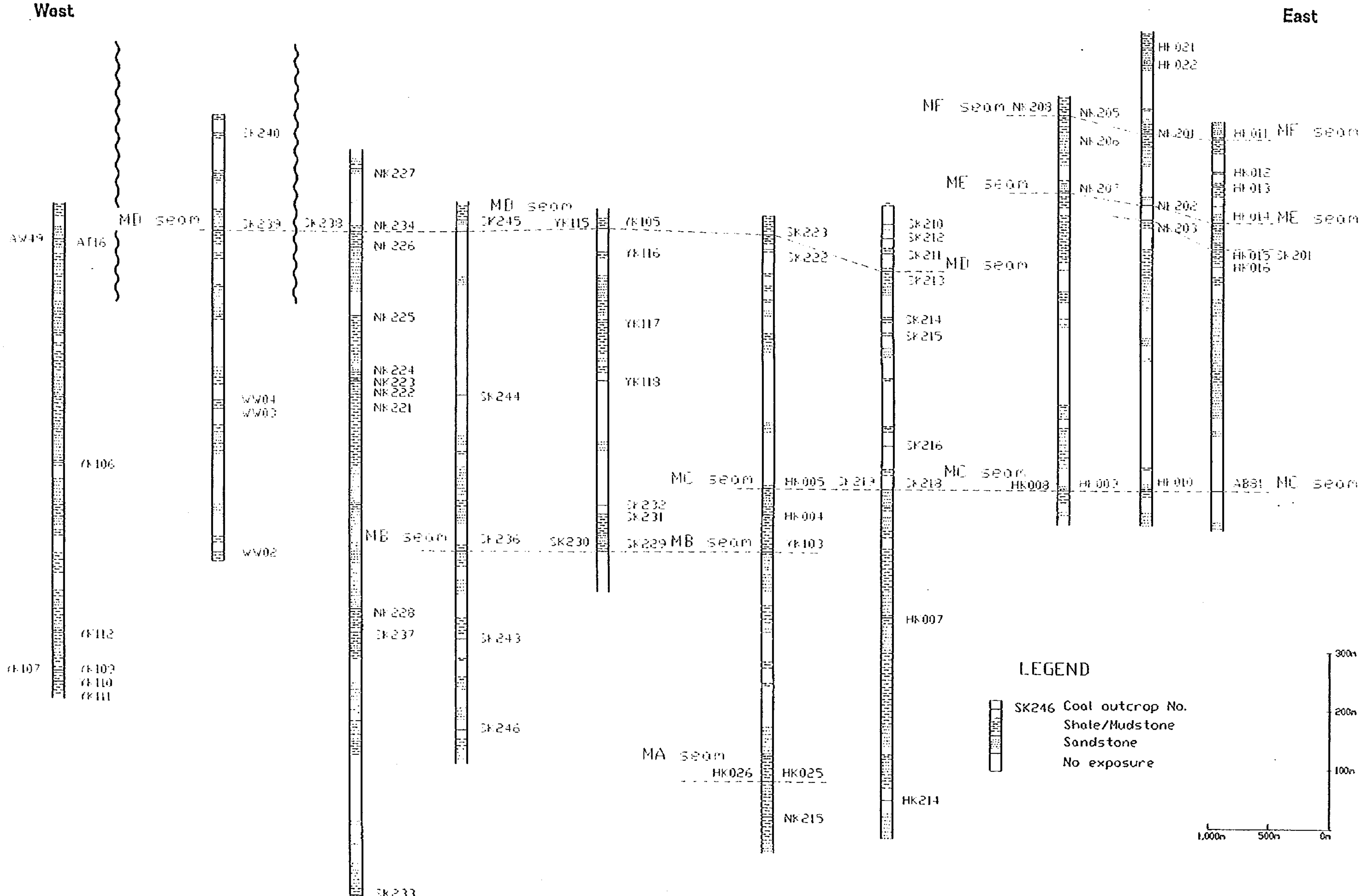


Figure 4-1 Coal Seam Correlation – Malibau

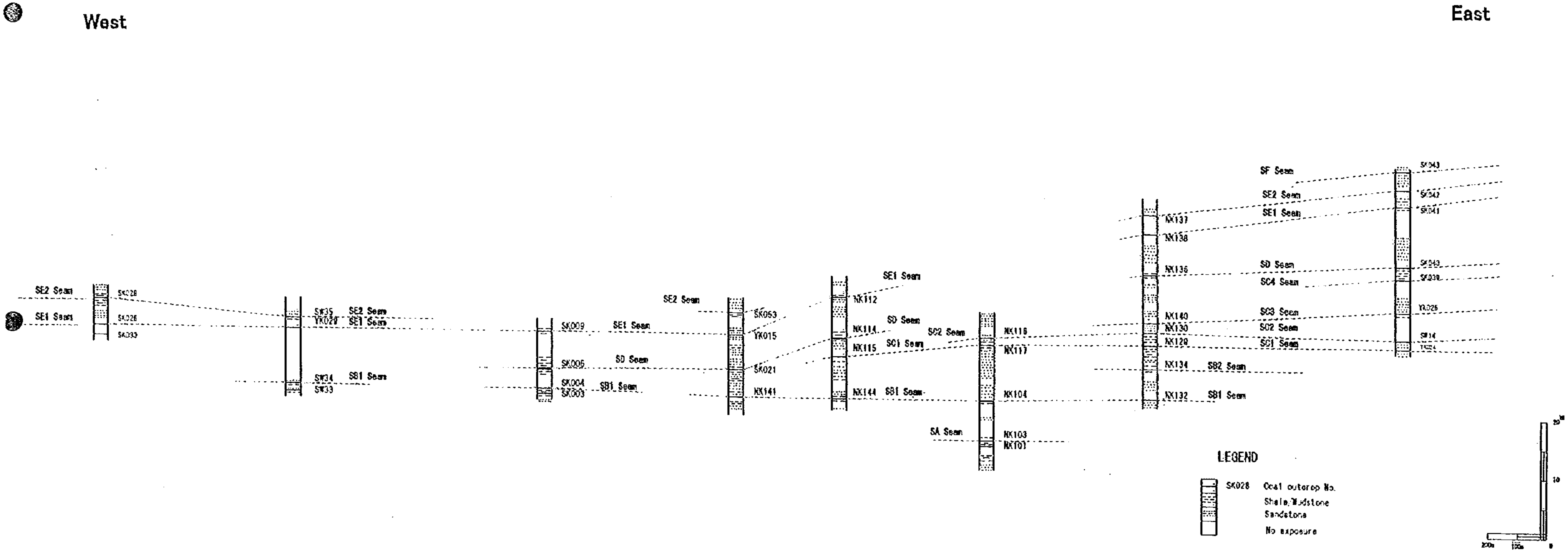


Figure 4-2 Coal Seam Correlation – Southwest Malibau

4.3. Silimpopon Area

4.3.1. Mode of Occurrence

Out of several coal seams in Silimpopon area, only the Queen Seam has mineable thickness. Almost all available data of the Queen Seam is included in the report by P. Collenette (1954), because no additional exploration was done since then except for observation and sampling of one outcrop of the Queen Seam during the present study.

The coal seam data included in the report is based on the following activities :

- Nine boreholes drilled in early 1900's
- Geological mapping by Collenette around 1950
- Record of an old coal mine operated between 1906 and 1932

The outcrops of the Queen Seam have been traced from the north to the southeast for a distance of about 7 km. The outcrops near the old mine mouth are more than 1.7 m thick. However, it seems that a parting at the lower part is thickening and coal above the parting is thinning and deteriorating toward the southeast and finally, the seam contains only coaly shale at the outcrop PC331.

In the western part, the Queen Seam was not exposed for a distance of 3 km. There are three thin coal outcrops at the southwestern part and they have been provisionally correlated to the Queen Seam. If the correlation is correct, they indicate the same thinning trend as in eastern part. Figure 4-3 shows the profiles of the Queen Seam formerly observed in outcrops, boreholes and an adit as well as one outcrop investigated in this study.

4.3.2. Geological Structure

The structure contours of the Queen Seam together with the representative cross sections of the area are also shown in Figure 4-4. The geological structure in the area is dominated by a broad syncline, of which axis plunges to the southeast. The Queen Seam lies in the eastern limb of the syncline with an average dip of 10 degrees to the south. The dip in the western limb seems to be more steep than in eastern limb.

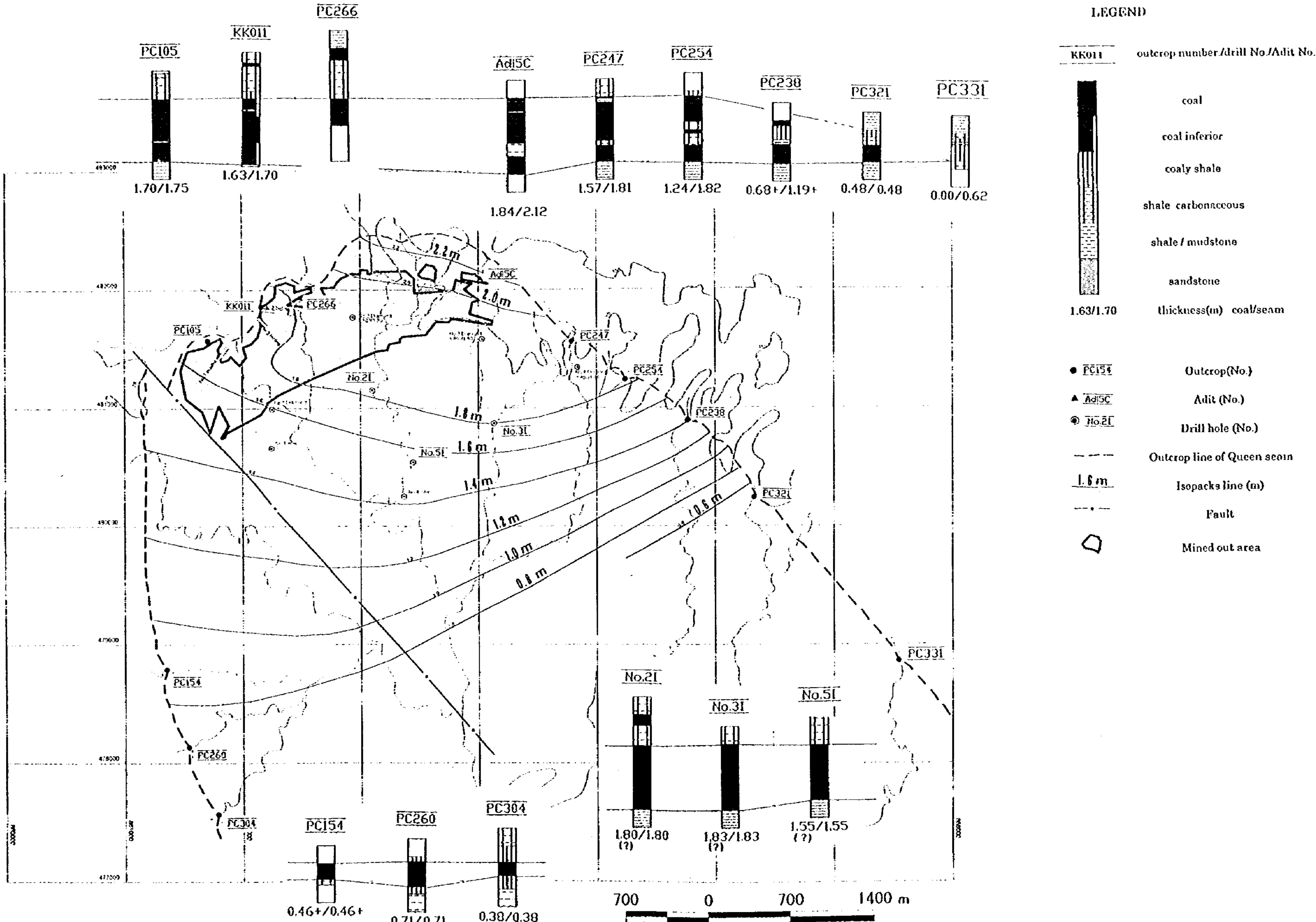


Figure 4-3 Coal Seam Profile of Queen Seam

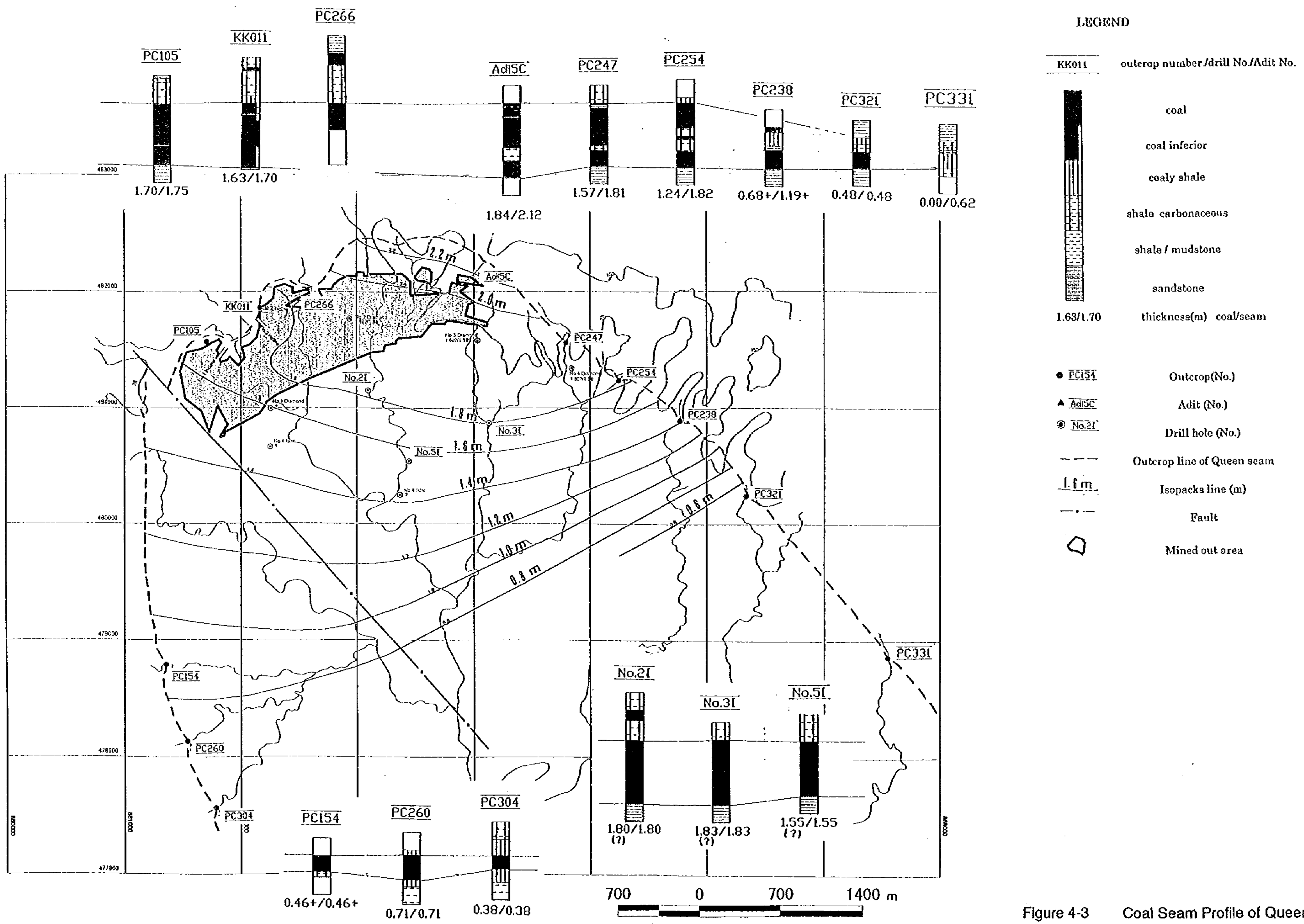


Figure 4-3 Coal Seam Profile of Queen Seam

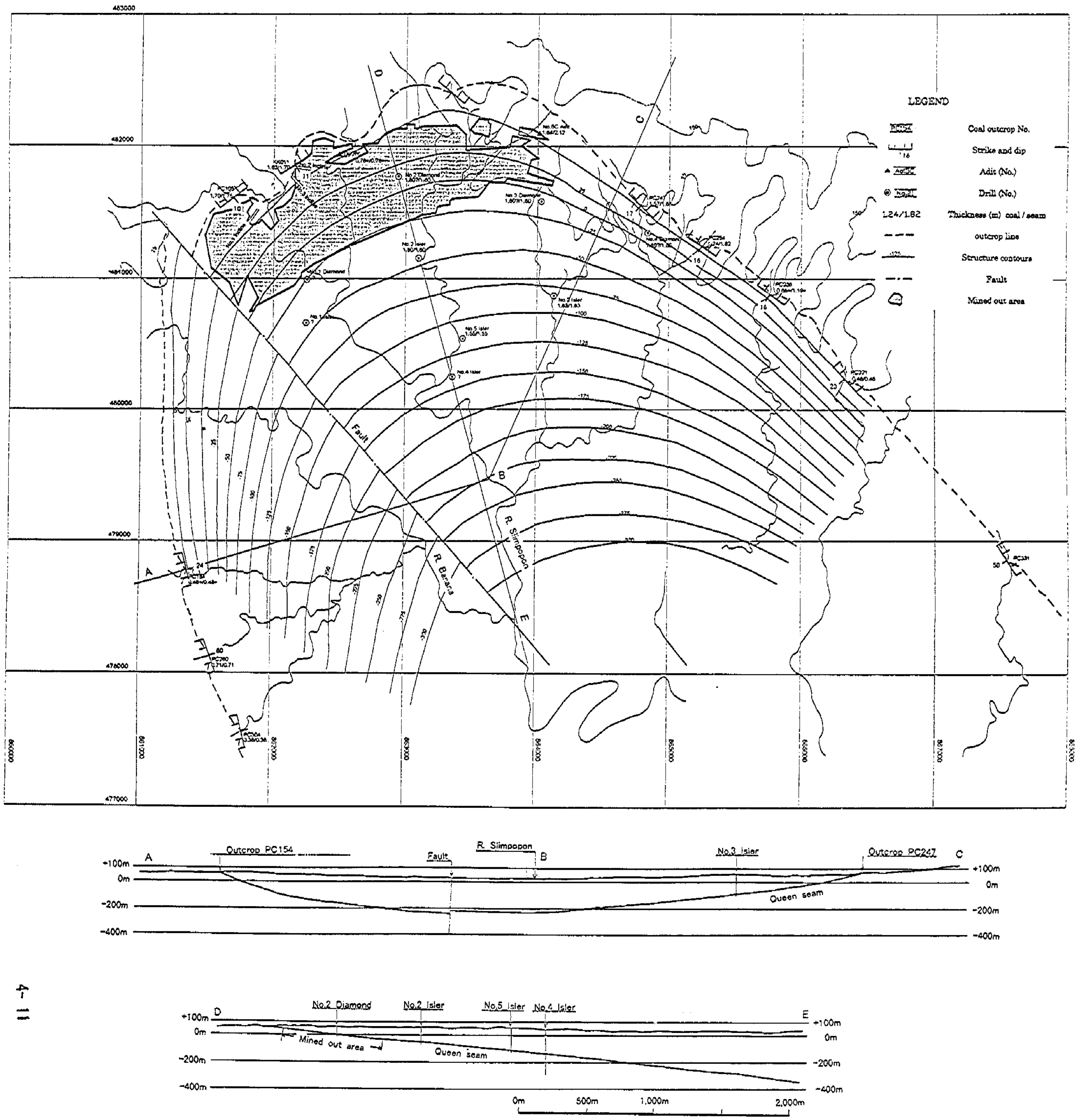


Figure 4-4 Geological Structure of Queen Seam

5. Estimate of Coal Resources

5.1. Criteria for Coal Resource Estimate

In-situ coal resources have been estimated in Malibau and Southwest Malibau areas. The estimate was made basically in accordance with the GSD's Reserve/Resource Classification System. The criteria adopted for resource estimate in this study are as follows :

(1) Resource class

Since the Phase 2 study is regarded as "General Exploration Stage of Geological Study" according to the definitions of GSD's system and the reliability of geological data has been improved by detailed mapping, the estimated resources are upgraded to "Indicated" in resource class.

(2) Coal seam

In Phase 2 study, correlation of coal seams has been established for the most part except thin and sporadically occurring coal seams. Therefore, coal resources are estimated for individual coal seams separately according to the correlation.

(3) Limiting factors

(a) Coal thickness

More than 0.6 m (excluding parting)

Average coal thickness of all outcrops is used for estimate of each block.

(b) Maximum distance of estimate

In strike direction from observation points : 1,000 m

In dip direction from the surface : 500 m

(c) If the next outcrop is less than 0.6 m, estimate area is limited to the distance divided proportionally by the thickness of two outcrops.

(d) Specific gravity of coal : 1.3

5.2. Coal Resources

On the basis of above mentioned criteria, resource tonnage of each coal seam block is shown in Table 5-1. Total "Indicated" coal resources are about 18 million tonnes in

Malibau area and 26 million tonnes in Southwest Malibau area.

The following characteristics of coal resources in each area are recognized from the above figures and table:

(1) In Malibau area, most of the other coal seams than main seams, which have been named MA to MF, were observed at only one outcrops. In Southwest Malibau area, on the other hand, all coal seams were observed at more than one place and consequently, their continuity were confirmed to some extent.

(2) With regard to the coal thickness, the weighted average by tonnage is 0.76 m in Malibau area and 1.27 m in Southwest Malibau area. Furthermore, all the coal seams in Malibau area except two isolated seams are less than 1 m in coal thickness.

(3) It is concluded from these data that the coal resources in Malibau area are unfavorable compared with those in Southwest Malibau with respect to thickness, continuity, and resource quantity.

Table 5-1 Coal Resources

Malibau Area

Seam	Observ. points (>0.6m)	Ave. Thickness (m)	Strike Distance (m)	Distance along dip (m)	Coal Resources (1,000t)
MF-1	1	0.63	1,100	500	85
MF Seam	3	0.73	1,800	500	652
ME-1	1	1.24	1,900	500	1,365
ME Seam	0	---	0		0
MD-1	1	0.61	2,000	500	793
MD Seam	9	0.68	4,830	500	2,135
MC-2	1	0.60	1,250	500	488
MC-1	1	0.65	2,000	500	845
MC Seam	6	0.89	1,630	500	943
MB-2	1	0.80	2,000	500	1,040
MB-1	1	0.88	2,000	500	1,144
MB Seam	5	0.89	1,310	500	758
MA-6	1	0.65	2,000	500	845
MA-5	1	0.90	2,000	500	1,170
MA-4	1	0.80	2,000	500	1,040
MA-3	2	0.64	2,450	500	1,019
MA-2	1	0.65	2,000	500	845
MA-1	1	1.05	2,000	500	1,365
MA Seam	3	0.87	2,420	500	1,369
Total					17,901

S.W. Malibau Area

Seam	Observ. points (>0.6m)	Ave. Thickness (m)	Strike Distance (m)		Coal Resources (1,000t)
SF Seam	2	1.65	2,390	500	2,563
SE2 Seam (Wm)	1	0.85	230	500	127
SE2 Seam (W)	9	1.55	2,020	500	2,035
SE2 Seam (E)	2	1.16	2,760	500	2,072
SE1 Seam (W)	20	1.52	3,310	500	3,278
SE1 Seam (E)	4	0.75	2,800	500	1,356
SD Seam (W)	2	1.30	560	500	473
SD Seam (E)	7	1.53	2,680	500	2,665
SC4 Seam	4	0.83	2,280	500	1,234
SC3 Seam	5	0.94	2,840	500	1,735
SC2 Seam	7	1.06	2,640	500	1,819
SC1 Seam	12	0.88	2,840	500	1,623
SB2 Seam	2	2.23	1,210	500	1,764
SB1 Seam	9	1.70	3,160	500	3,496
Total					26,230

6. Evaluation of Coal Quality

During the study of Phase 1 and Phase 2, a total of 56 samples were collected from the outcrops in Malibau, Southwest Malibau and Silimpopon areas. They were analyzed at laboratories in GSD Sarawak and in Japan. Table 6-1 is a summary of main quality parameters extracted from all analytical results.

Analytical result is evaluated from the view point of utilization as steaming coal in comparison with values in Table 6-2 which summarize the typical coal quality requirements for power generation, commonly used for imported coal in Japan.

(1) Total Moisture

Total moisture consists of surface and inherent moisture and the amount of surface moisture is normally not more than 10 %. Therefore, in the case of the coal with from 2 to 3 percent of inherent moisture as in this area, total moisture can be easily kept within its limit shown in the Table 6-2.

(2) Ash

Raw ash content of the main coal seam in the area is low in Southwest Malibau, low to medium in Silimpopon and medium in Malibau in general. When considering the mining plan, however, the ash content of product coal can be kept within its limit.

(3) Volatile Matter

High volatile bituminous coal in this area is regarded as the most suitable for combustion in terms of volatile matter content.

(4) Sulphur

Sulphur content of the main coal seam in Malibau and Southwest Malibau area is in an acceptable level. In Silimpopon area, however, the Queen Seam contains about 2% sulphur. Further study is required on utilization of Silimpopon coal, including sulphur reduction by washing and utilization for cement industry which allows the use of higher sulphur coal than power station.

(5) Nitrogen

The nitrogen content of coal in the area is low and no problem on utilization.

(6) Calorific Value

Limiting value shown in Table 6-4 is an example which is commonly used in Japanese power companies for imported coal. Even the coal of much lower calorific value can be used in appropriate type of boiler to meet its quality specification. In order to obtain the coal of 6,500 kcal/kg, the corresponding ash content in each area, 17% in Malibau, 13% in Southwest Malibau, and 19% in Silimpopon shows enough values.

(7) Hardgrove Grindability Index (HGI)

HGI of the coal in the area is more than 50 compared with the requirement of 40 to 45 for steaming coal.

(8) Ash Fusion Temperatures (AFT)

Although the limiting value of AFT is different by companies, IDT (Initial Deformation Temperature) of more than 1,200℃ is commonly used for pulverized coal combustion. Most of samples show the higher value than 1,200 ℃, though four samples out of fifteen have lower IDT than 1,200℃.

(9) Ash Analysis

The many kinds of indices are proposed for the purpose of predicting slagging and fouling tendencies during combustion of coal. Some examples commonly used limiting value in parenthesis are shown in comparison with the calculated values on each sample in Table 6-3, in which the values beyond the limit are underlined. In this table, slight tendencies of slagging and fouling are found in several samples, however, this point is judged that there is no serious problem.

Table 6-1 SUMMARY OF MAIN QUALITY PARAMETERS

AREA	MALIBAU		SW-MALIBAU		SILIMPOPON
	Average	(Range)	Average	(Range)	(1 sample)
Proximate Analysis (%)					
Moiture (ad)	2.7	(0.6 - 6.2)	4.0	(2.9 - 5.2)	1.7
Ash (ad)	21.5	(3.4 - 48.2)	12.8	(2.9 - 43.0)	17.3
Volatile Matter (daf)	46.6	(43.9 - 51.2)	46.9	(44.3 - 50.2)	48.1
Fuel Ratio	1.15	(0.95 - 1.28)	1.13	(0.99 - 1.26)	1.08
Calorific Value (kcal/kg)					
(air dried b.)	5,923	(3,633 - 7,571)	6,305	(3,371 - 7,456)	6,564
(dry ash-free b.)	7,818	(6,795 - (8,679)	7,560	(6,482 - (,087)	8,103
Total Sulphur (ad. %)	1.46	(0.26 - 3.79)	1.05	(0.29 - 2.84)	1.83
Ultimate Analysis (daf. %)					
Carbon	79.40	(72.30 - 82.90)	78.27	(70.40 - 81.20)	81.00
Nitrogen	1.69	(0.85 - 2.41)	1.27	(1.07 - 1.51)	1.11
Oxygen	11.10	(7.20 - 18.43)	13.33	(10.73 - 15.64)	9.15
Free Swelling Index (FSI)	1.1	(0 - 2)	0.7	(0 - 1)	2
Hardgrove Gridability I. (H	58.0	(51.9 - 70.1)	50.1	(40.4 - 54.9)	54.9
Ash Fusion Temp. (deg.C)					
Initial Deformation T.	1,317	(1,075 - 1,505)	1,277	(1,100 - 1,495)	1,385
Hemispherical T	1,377	(1,120 - 1,550)	1,341	(1,160 - 1,565)	1,430
Ash Analysis (dry, %)					
SiO2	50.26	(43.30 - 58.40)	43.64	(27.20 - 51.40)	45.40
Al2O3	27.07	(19.69 - 31.91)	30.52	(22.42 - 38.20)	32.74
Fe2O3	8.38	(3.40 - 16.19)	8.17	(3.97 - 17.34)	11.01
CaO	2.23	(0.93 - 4.00)	3.85	(1.00 - 5.68)	1.81
MgO	2.77	(1.70 - 5.45)	4.19	(1.70 - 7.97)	1.93
Na2O	0.73	(0.23 - 1.91)	1.13	(0.30 - 4.01)	2.35
K2O	2.82	(1.94 - 3.36)	1.77	(0.98 - 2.37)	0.32
TiO2	1.13	(1.03 - 1.38)	1.18	(0.84 - 1.39)	1.72
Coal Rank	hvAb	(hvAb - hvCb)	hvBb	(hvBb - hvCb)	hvAb

Table 6-2 Quality Requirements for Power Plant

Quality Parameter	Unit	Limit
Gross Calorific Value	kcal/kg	> 6,000 - 6,200
Total Moisture	ar %	< 10 - 12
Ash	ad %	< 15 - 20
Volatile Matter	ad %	> 18 - 20
Fuel Ratio		< 2.0 - 2.5
Sulphur	ad %	< 1.0 - 1.2
Nitrogen	daf %	< 1.8 - 2.2
Grindability (HGI)		> 40 - 45
Ash Fusibility		
Initial Deformation T.	deg. C	> 1,150 - 1,250
Hemispherical T.	deg. C	> 1,250 - 1,300
Ash Composition		
Na2O	dry %	< 2.0 -3.0
Base/Acid Ratio		< 0.5
Slagging Factor		< 0.6
Fouling Factor		< 0.2

Table 6-3 Summary of Ash Indices

Indices	IDT (℃)	B/A ratio	Slagging F.	Fouling F.	Na2O (%)
Requirement	>1,200	< 0.5	< 0.6	< 0.2	< 2.0
Malibau					
SK208	1,300	0.25	0.48	0.14	0.55
SK224	1,385	0.18	0.40	0.10	0.53
SK238	1,075	0.46	1.16	0.88	1.91
SK217	1,425	0.42	0.17	0.03	0.23
SK230	1,360	0.19	0.56	0.03	0.17
SK246	1,170	0.22	0.07	0.28	1.24
HK026	1,505	0.14	0.05	0.07	0.46
SW Malibau					
SW25	1,495	0.16	0.15	0.05	0.36
SK015	1,155	0.48	0.18	1.95	4.01
SW37	1,345	0.18	0.18	0.14	0.78
SK040	1,315	0.22	0.07	0.17	0.77
SW18	1,240	0.23	0.07	0.25	1.10
Nk129	1,100	0.34	0.97	0.10	0.30
NK104	1,290	0.23	0.21	0.14	0.60
Silimpopon					
KK011	1,385	0.22	0.41	0.52	2.35

7. Preliminary Study on Coal Mine Development

Based on the geological assessment of coal seam conditions in the area, the coal mine development plan has been studied. Since the exploration is still in the early stage without any exploratory drilling to the deeper part except for several old boreholes in Silimpopon area, the mine plan is also preliminary and conceptual. Some assumptions have been applied in mine planning as well as cost estimate.

Malibau area was excluded from the area for mine plan, because coal seams are too thin to be mined economically by underground mining method.

7.1. Silimpopon Area

7.1.1. Basic Consideration

(1) Old Colliery's Records

In the northern part of the area, there was a colliery which was operated for 27 years from 1906 to 1932. Production record gives the total tonnage of 1,348,952 tons (probably in long ton) between 1909 and 1929, although that of first and last three years is unknown. The average annual production is 64,236 tons and the maximum is 90,012 tons in 1924. Several inclines, adits and shafts were driven and the coal seam was mined by "pillar and stall method". Product coal was transported by rail from the mine to No.2 Wharf, about 7 km south along Silimpopon river.

(2) Mining Area

The selected mining area is bounded on the southeast by an isopach line of 1.2 m which was adopted as the minimum mining thickness in this study. On the southwestern side, the positions of two boreholes, Isler No.1 and No.4, were excluded from the mining area, because there is the possibility of deterioration of the Queen Seam in these boreholes. On the northern side, 100 m along the seam from the old mine and coal outcrops are to be left unmined as safety barriers in order to prevent water inflow into the mine.

(3) Recoverable Reserves

Recoverable reserves have been estimated according to the mine plan mentioned in the next section. Reserve calculation was made on raw coal basis in each panel and roadway. The values applied for the parameters in the above formula are as follows :

mining thickness (m)	: 1.2 - 1 85 (determined by isopach map)
recovery factor (%)	: longwall - 95, board and pillar - 33, roadway - 100
specific gravity	: 1.4 (raw coal)

Total recoverable reserves in the planned area is approximately 3.7 million tonnes.

7.1.2. Mine Design and Mining Method

(1) Mine Access and Roadway Development

General layout of the underground mine in Silimpopon is shown in Figure 7-1. Two parallel slopes are driven in the rock above the Queen Seam at an interval of 50 m from portals. The inclination of the rock slopes is 18 degrees. After reaching the Queen Seam at about 320 m from the portals, the slopes are driven along the seam at an inclination of about 6 degrees.

As in-seam slopes advance, nearly horizontal roadways, slightly upward, are driven to the both sides of the slopes at regular intervals. They become the upper and the lower roadways of the mining panel, of which size is 100 m in width and 500 m to 1,700 m in length. Coal barriers of 20 m is left between upper and lower panels.

(2) Mining Method

"Semi-mechanized "longwall mining" (L/W) and "board and pillar mining" (B/P) were selected as the suitable mining methods for the geological condition in the area. The latter is applied under the river to the extent of 100 m on both sides of the river, so as to minimize the effect of mining on the surface due to its small mining recovery rate and consequently, to prevent water inflow from the river.

In L/W mining, coal is broken by blasting and coal picks and moved by chain conveyors from working face to lower roadway.

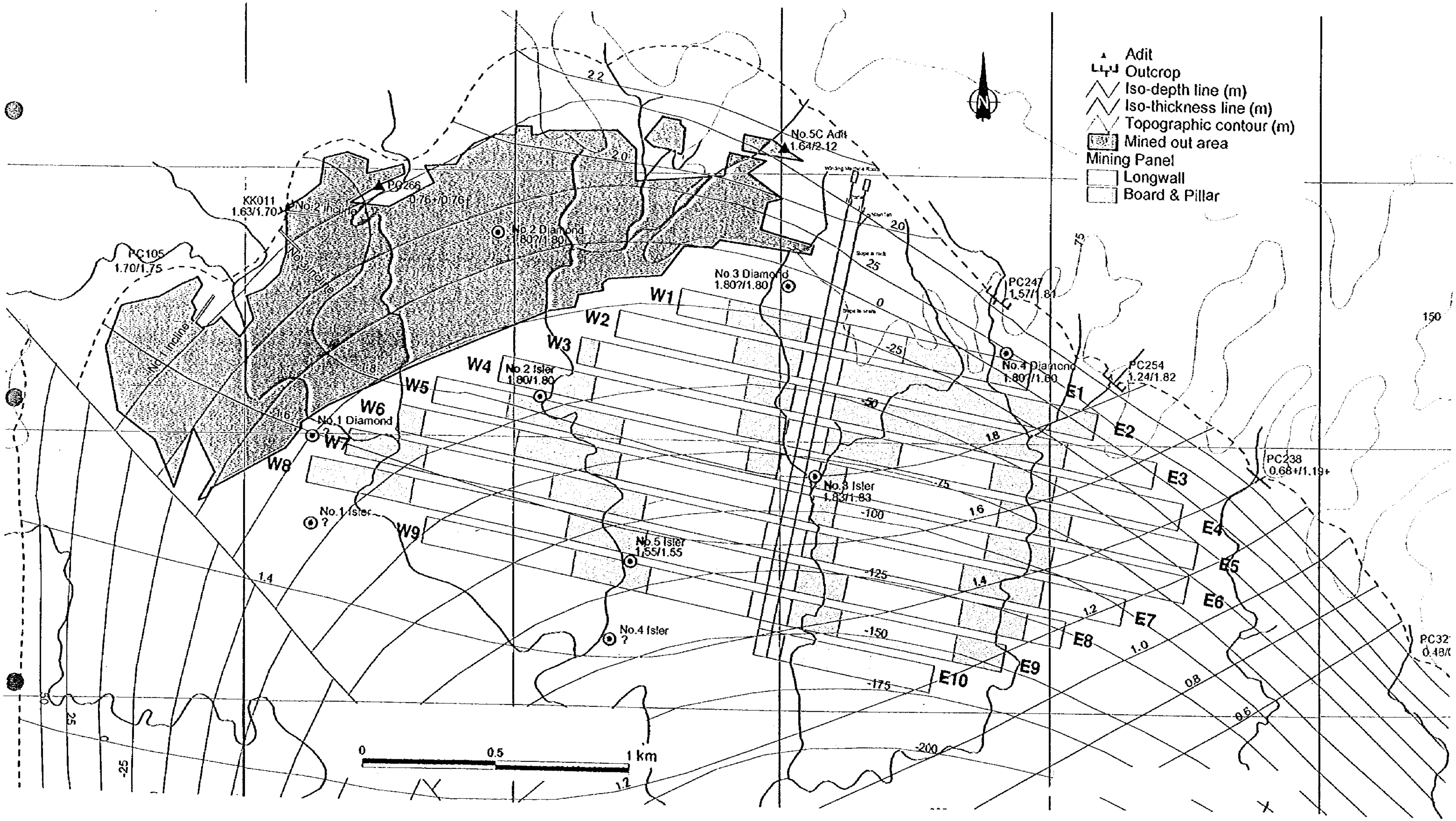


Figure 7-1 Mining plan - Silimpopon

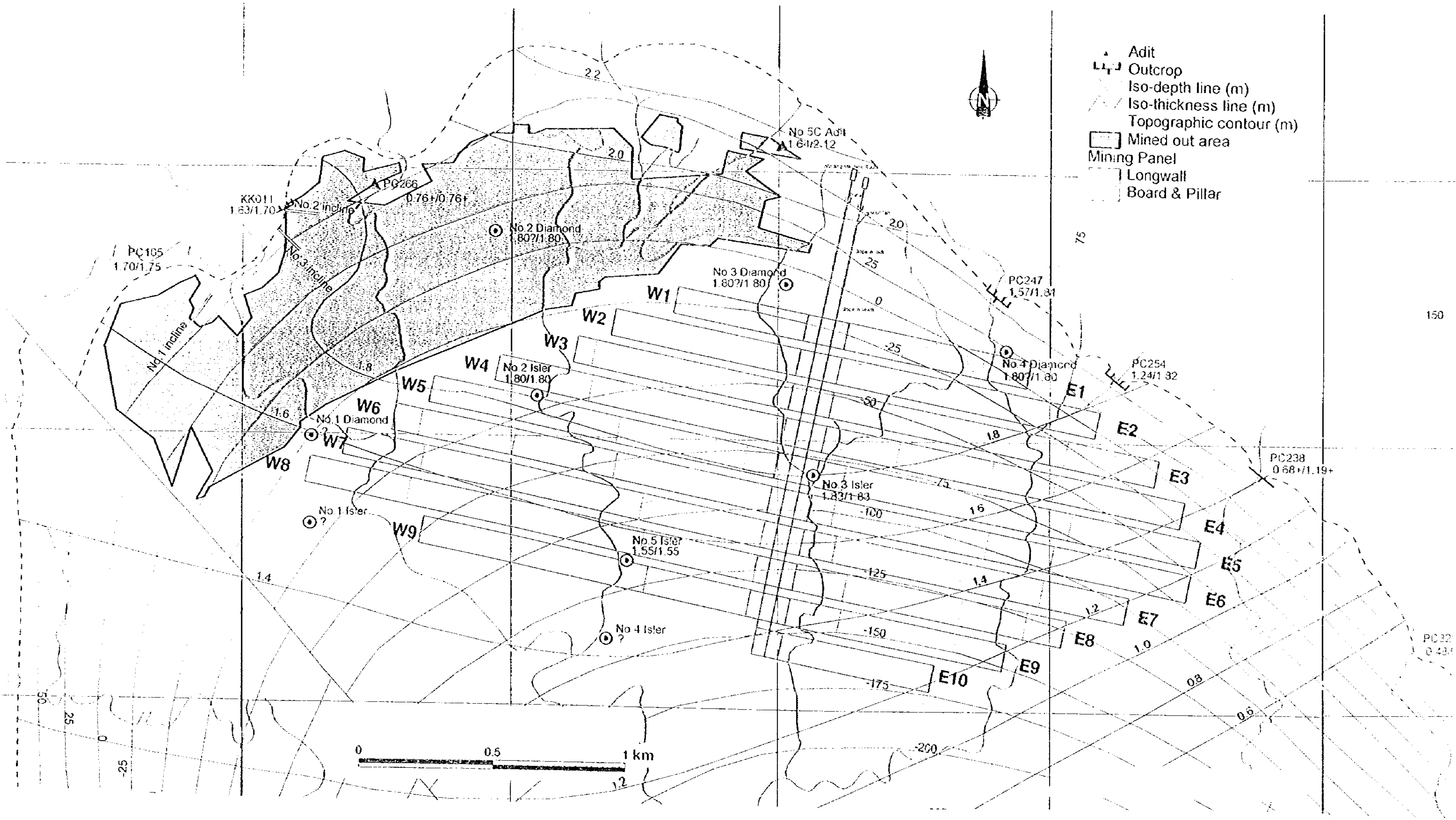


Figure 7-1 Mining plan - Silimpopon

In B/P system, coal of 5 m wide is mined upward at right angle to roadway and next 10 m coal is left unmined as a pillar. Thus, coal extraction rate lowers to one thirds (33%) in a mining block.

Mined coal is transferred from chain conveyors into mine cars at a lower level roadway, then hauled by battery locomotives. Finally, they transported to the surface through the slope by a winding machine installed near the portal.

7.1.3. Coal Production

Schedule of roadway development and coal production has been estimated on the following assumptions.

(1) Work Schedule

The mine operation is carried out on the following basis :

Working days = 5 days/week x 52 weeks/year - holidays (10 days) = 250 days/year

Working shifts = 8 operating hours x 3 shifts/day

Number of teams working in each face is as follows :

(a) Roadway driving

mine years	1 - 5	6 - 11	12 - 21
number of team(s)	2	1 - 2	1

(b) L/W mining

regular team : 1 team/shift x 3 shifts/day

additional team : 1 team in a separate panel,
years 11 to 22 - 1 shift/day, afterward 2 shifts/day

(c) B/P mining

regular team : 4 teams/shift x 3 shifts/day

additional team : ① years 6 and 9 - 3 teams/day, ② years 11 to 22 - 4 teams/day

(2) Rate of Advance and Coal Production

(a) Roadway driving

Table 7-1 Advance Rate and Coal Production

	Rock Slope	In-seam Slope	In-seam Road
Advance Rate (m/shift)	1.0	1.2	2.4
(m/day)	3.0	3.6	7.2
Coal Production (t/m)*	-	8.1 - 11.3	7.4 - 11.3
(t/shift)	-	29.2 - 40.7	53.3 - 81.4

* depending on coal seam thickness

(b) L/W mining

coal production by 1 m advance in 100 m long face : 165 t - 246 t (depending on seam thickness, 95% recovery ratio)

Average advance of the face (cycle) : 0.72 m/shift → 2.16 m/day

Rate of coal production : 119 t - 177 t/shift → 357 - 531 t/day

(c) B/P mining

Advance rate : 3.6 m/shift/team → 10.8 m/day/team

Coal production rate : 8.7 - 13.0 t/m

regular team : 375 - 562 t/day

additional team : ① 140 t/day, ② 152 - 179 t/day

(3) Production Schedule

Based on the above standards and assumptions, the coal production schedule has been established as shown in Table 7-2. According to this schedule, the average annual production during full production period is about 160 thousand tonnes on raw coal basis including 15 thousand tonnes from roadway development. Estimated recoverable reserves of 3.7 million tonnes will be exhausted after 24 years' mining operation.

7.1.4. Work Force

Table 7- 3 is a summary of required number of work force on the registered basis in the whole mine organization.

Table 7-2 Production Schedule Silimpopon Mine (1,000t)

Panel	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	
West 1		[133d] 71.6																							71.6
East 1		[19d] 10.6	[152d] 82.1																						92.7
West 2			[93d] 52.2	[149d] 80.0																					132.2
East 2				[101d] 55.4	[49d] 26.9																				82.3
West 3					[201d] 107.0	[102d] 54.6																			161.6
East 3						[143d] 69.0	[145d] 78.0																		147.0
West 4						[174d] 24.1	[12d] 62.5 [105d]	[180] 96.1																	182.7
East 4								[70d] 30.4 [148d]	[250d] 134.9	[106d] 56.0															221.3
West 5										[144d] 75.0	[250d] 133.7	[39d] 22.5													231.2
East 5												[214d] 85.3	[250d] 121.5	[66d] 42.9											249.7
West 6											[110d] 18.6	[250d] 41.9	[250d] 42.4	[250d] 39.3	[250d] 41.9	[250d] 41.9	[189d] 31.5								257.5
East 6														[164d] 62.1	[250d] 108.7	[139d] 65.1									235.9
West 7																[111d] 52.5	[250d] 120.3	[174d] 82.5							255.3
East 7																	[61d] 7.4	[250d] 30.3	[250d] 32.6	[250d] 36.1	[250d] 36.3	[127d] 33.1			175.8
West 8																		[76d] 35.1	[250d] 111.8	[250d] 113.8	[2d] 0.9				261.6
East 8																						[123d] 30.1	[250d] 67.2	[124d] 31.8	132.1
West 9																					[245d] 110.3	[240d] 105.4			215.7
East 9																						[10d] 3.8	[247d] 95.9		99.7
East 10																							[3d] 1.1	[250d] 95.5	96.6
Mining face		82.2	134.3	135.4	133.9	147.7	140.5	126.5	134.9	131.0	152.3	149.7	163.9	144.3	150.6	159.5	159.2	147.9	144.4	149.9	147.5	172.4	164.2	130.3	3,302.5
Road develop	3.6	25.0	29.1	26.7	26.6	17.8	25.6	25.6	17.7	25.7	17.1	12.9	12.1	10.8	11.1	12.2	12.8	8.0	12.0	10.9	11.9	1.2	0.0	0.0	356.4
Total	3.6	107.2		162.1	160.5	165.5	166.1	152.1	152.6	156.7	169.4	162.6	176.0	155.1	161.7	171.7	172.0	155.9	156.4	160.8	159.4	173.6	164.2	130.3	3,658.9
	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21	Y22	Y23	Y24	

▬▬ Regular team

■ ■ ■ ■ Additional team