3.2.4 Mining plan

Since the coal beds in the Nong Plab Basin occur in greater depth than economically mineable depth by openpit method, a conceptual underground mining plan of the Upper Coal Bed (as shown in Fig.3.2-12) were studied as outlined below.

(1) Basic conditions

1) Mining area

A block bounded by E and F faults in the northeastern part is selected for the mine planning area with the following reasons;

- more than 1.5 m in coal thickness
- stable geologic structure within the block
- relatively large reserves compared to other blocks

2) Portal location and mine access

After comparing several ideas, proposed portal location is decided, in consideration of maximizing mineable reserves, minimizing the length of rock slopes, proximity to the existing road and keeping enough space for surface facilities. (Ph. 3.2-4)

Two rock slopes are to be driven to reach the underground coal bed. Each slope is 345 m long and 10 degrees in inclination.

3) Mining thickness

The thickness of the Upper Coal Bed varies from 3.55 m to 1.90 m in the mine planning area. In this study, mining thickness of 2 m from the roof is adopted from the aspect of suitable mining technology.

4) Mineable reserves

Mineable reserves has been estimated with the following formula;

Mineable reserves (raw coal)

= mining area x mining thickness x specific gravity x mining recovery

The values applied for the above formula are as follows;

mining area (m^2) : measured on the mining plan

mining thickness (m) : 2.0

specific gravity : 1.4

mining recovery (%) : 95 for L/W, 33 for R/P, 100 for Roadway

The total mineable reserves in the planned area is approximately 2 million tons.

(2) Mining system

General mine design is illustrated in Fig.3.2-12.

1) Mining method

Semi-mechanized longwall retreat method (L/W) is proposed in the major part of the mining area. In shallow areas of less than 40 m from the surface, room and pillar method (R/P) is planned to minimize surface subsidence.

Dimensions for the two mining methods are as follows;

L/W : Panel size - 95 m wide x 500-800 m long

Support - hydraulic props at intervals of 0.6 m with linkbars of 1.2 m long

R/P : Mining - 5 m wide x 95 m long

Support - three hydraulic props combined with steel beam

Pillar - 1 0 m wide to be left unmined

Semi-mechanized mining system is illustrated in Appendix 2.

2) Roadway development

All roadways are driven in a pair with the following standard;

Distance between the pair

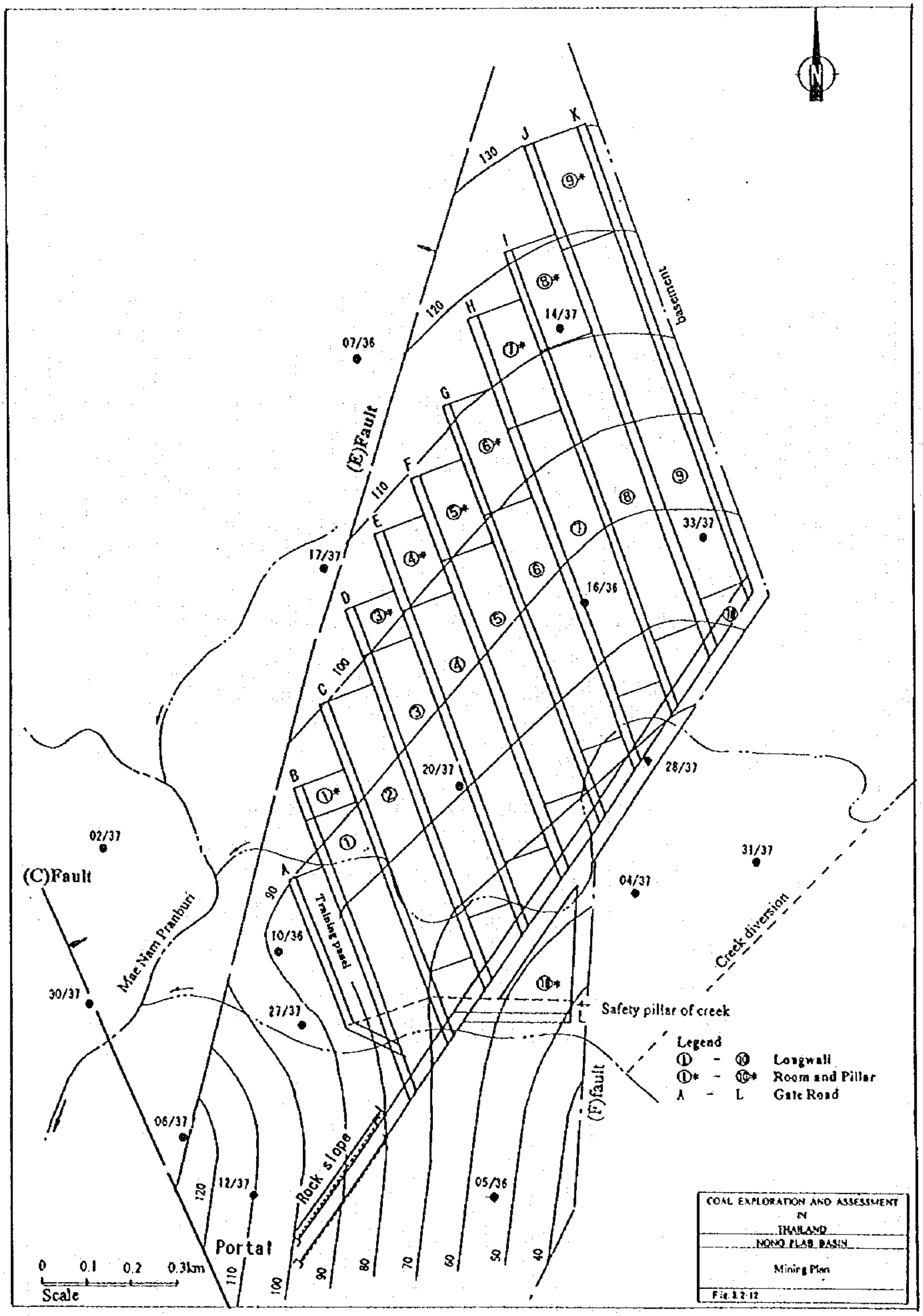
Rock slopes and main entry : 30 m

Gate roads in longwall panel: 20 m

Size of roadway

width : 4 m at roof, 5 m at floor, height: 2.5 m

Support : steel props combined with a steel beam



(E)Fault
(C)Fault
(F)fault
basement
Mae Nam Pranburi
Creek diversion
Safety pillar of creek
Training panel
Rock slope
Portal
07/36
14/37
17/37
33/37
16/36
02/37
20/37
28/37
31/37
04/37
10/36
30/37
27/37
06/37
12/37
05/36
Legend
① - ⑩ Longwall
①* - ⑩* Room and Pillar
A - L Gate Road
0 0.1 0.2 0.3km
Scale
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
NONG PLAB BASIN
Mining Plan

3) Transportation

Coal is broken by blasting and transported to the surface by the following way;

L/W : chain conveyor- belt conveyor

R/P : side-dump, loader, chain conveyor-belt conveyor

(3) Coal production

Coal production from the proposed mine is estimated on the following assumptions;

1) Working system

Working days : 3 shifts /days, 250 days/year

Number of production crews per shifts

Longwall : 1 crew

Roadway and Room & Pillar :

Two crews for road development before preparation of first mining panel, afterward 1 crew for R&P and road development alternately.

2) Production rate

	Production (t/m),	Advancing rate (m/d),	Production rate (t/d)
Longwall	3.2	126.0	402.0
Room & Pillar	14.0	4.8	67.2
Roadway	12.3	4.8	59.1

3) Production schedule

Based on the above assumptions and estimated mineable reserves, the coal production schedule has been established as shown in Table 3.2-6. The average annual production at full production period is about 130,000t, including 100,000t from longwall mining. The mineable reserves of the two million tons will be exhausted after nineteen years' mining operation.

4) Work force

The following numbers of work force are required at full production period;

	Workers	Staff	Total
Direct *	161	27	188
Indirect	191	73	264
Total	352	100	452

* directly related to production work

The above number is for registered work force which includes allowance for attendance rate of 85% for direct workers and 90% for indirect workers.

Table 3.2-6 Production Schedule

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Production
Surface Construction	=====																			
(346m) Slope(rock)	====																			
(1450m) Slope(coal)	1,180	5,470	3,700	11,820				3,700		3,700	5,910	250								35,730
Coal Heading A(960m)		11,830																		11,830
(715m) B		17,620																		17,620
(1,580m) C		10,400	9,070																	19,470
(875m) D			10,050	11,510																21,560
(930m) E				6,260	16,660															22,920
(925m) F					3,420	19,370														22,790
(1,005m) G							23,410	1,350												24,760
(990m) H								6,970	17,420											24,390
(1,055m) I										15,030	10,970									26,000
(1,175m) J												28,950								28,950
(1,090m) K													16,210	10,650						26,860
(240m) L																		5,910		5,910
R.P. (1)			7,700																	7,700
(2)					10,780															10,780
(4)						11,560	6,920													18,480
(5)								20,020												20,020
(6)									13,840	12,340										26,180
(7)											21,560									21,560
(8)												600	22,500							23,100
(9)														22,890	1,750					24,640
(10)																		16,670	2,740	19,410
L.W. Training Panel		23,700	32,160																	55,860
L.W. (1)			57,200	46,410																103,610
(2)				53,600	100,000	6,860														160,460
(3)						93,200	63,470													156,670
(4)							36,400	100,000	13,960											150,360
(5)									86,000	59,300										145,300
(6)										40,800	99,450									140,250
(7)											400	100,000	58,800							159,200
(8)													41,200	100,000	30,640					171,840
(9)															69,200	100,000	36,750			205,950
(10)																	47,400	22,760		70,160
Heading	1,180	45,320	22,820	29,590	20,080	19,370	23,410	12,020	17,420	18,730	16,880	29,200	16,210	10,650	0	0	0	5,910	0	288,790
R&P	0	0	7,700	0	10,780	11,560	6,920	20,020	13,840	12,340	21,560	600	22,500	22,890	1,750	0	0	16,670	2,740	171,870
L.W.	0	23,700	89,360	100,010	100,000	100,060	99,870	100,000	99,960	100,100	99,850	100,000	100,000	100,000	99,840	100,000	84,150	22,760	0	1,519,660
Y Production	1,180	69,020	119,880	129,600	130,860	130,990	130,200	132,040	131,220	131,170	138,290	129,800	138,710	133,540	101,590	100,000	84,150	45,340	2,740	1,980,320

(4) Cost estimation

An attempt is made to estimate the capital and operating costs for the present mining plan. It should be noted that the mining plan is only conceptual, and unit cost used for the estimation is not always taken from domestic standards. Because, most of the coal mining equipment are not prevalent in Thailand. Consequently, the estimated costs summarized below should be regarded as at rough level in accuracy. The basis of the estimation is same as that of underground mine in the Mae Lamao Basin which is described in Appendix 3.

1) Capital cost (Initial)

		(US$)
Preparation work and slope construction	:	992,000
Surface facilities and equipment	:	3,400,000
Vehicles and mobile equipment at surface	:	860,000
Safety equipment	:	982,000
Underground transportation	:	1,500,000
Road development and room and pillar	:	2,784,000
Longwall mining	:	2,258,000
Others	:	450,000
Total		13,226,000

Replacement of equipment at later stage is not included.

2) Operating cost (in 5th year)

		(US$/year)
Personnel cost	:	1,534,700
Consumable for mining face	:	1,415,600
ditto for road development/maintenance	:	879,150
Electric power	:	343,200
Others	:	500,000
Total	:	4,672,650

Coal production : 130,860t → Unit cost : 35.7 $/ROM t

The above is the cash cost at mine site. Transportation cost, royalty or tax, depreciation etc. are not included.

(5) Surface environment

The surface of the mining plan area is utilized mostly for corn and pineapple field. Village, irrigation system or any other things to be affected by mining are not found in the area. It is unlikely, therefore, that mining activities have a significant influence to the surface environment.

One thing to be considered is, however, a small creek above the southern part of the mine planning area. It may be required to be diverted to the outside of the area depending upon the amount of water flow. More detailed survey is necessary on this matter. Ph.3.2-3 is a general view of the mining plan area.

(6) Coal quality

The quality of the product coal from the mining plan area has been estimated. However, owing to the limited number of available analytical data and inadequate sampling method, some modifications and assumptions are applied for the estimation as described below;

1) Mining section (planed mining height)

The following modification are made for the thickness of coal and partings in the mining section after comparing original core logs with analytical data;

- Where the thickness of the coal bed is less than 2 m, carbonaceous mudstone of the floor is included to meet the minimum mining thickness of 2 m.
- Two thin coal plies at NP27/37 and NP28/37 are changed to carbonaceous mudstone because of their high ash content.
- The lower half of the coal bed in NP10/36 is doubtful in quality due to its abnormal thick coal. Therefore, this portion is included into mining section as carbonaceous mudstone.

After the above modifications, the thickness of each lithologic component in mining thickness is determined averaging those of six boreholes as shown below;

Coal	1.58 m
Carbonaceous mudstone	0.30 m
Mudstone	0.41 m *
Total	2.29 m

* including 5 cm of out-of-seam dilution

2) Quality of coal and partings

Quality of coal, carbonaceous mudstone and mudstone are assumed as follows;

Coal : an average of seven analytical data in and close to the mining plan area

Carb. mudstone : an average of two data of NP28/37 and NP27/37

Mudstone : owing to the lack of analytical data, it is assumed to be of no heating value.

Using the estimated quality values of each component, the quality of the mining section on a dry basis is calculated as a weighted average by thickness and specific gravity. The quality of run-of-mine is obtained by adding assumed moisture content as follows; 30 % for coal, 25% for carbonaceous mudstone and 20% for mudstone.

3) Quality of product coal

The quality of final product is estimated on the assumption that 80% of mudstone is to be removed from run-of-mine coal by screening and hand-picking.

The results of the estimation of product coal quality by way of the above procedures are shown in Table 3.2-7.

4) Possible demand for the product

Due to relating low heating value, the product is expected suitable for the power plants. Further benefication to increase its heating value is not realistic from the aspect of not plenty resources.

Table 3.2-7 Coal Quality of Nong Plab Proposed Mine

hole No.		sample No.		from	to	thick	as analysed basis SpGr	M	ASH	VM	FC	(FR)	CV	TS	dry basis SpGr	ASH	VM	CV	TS	TSmg/kcal	ASTM class Btu/lb	Class
Coal																						
NP	7 /36	NPC	4	121.00	121.05	0.05	1.360	19.22	9.64	33.56	37.58	1.12	4936	1.56	1.487	11.93	41.54	6110	1.93	3.16	9925	subB
NP	10 /36	NPC	9	69.00	69.05	0.05	1.402	13.13	23.20	33.52	30.15	0.90	4204	3.16	1.493	26.71	38.59	4839	3.64	7.52	10121	subB
NP	16 /36	NPC	12	79.00	79.05	0.05	1.548	14.02	42.66	23.72	19.60	0.83	2737	2.75	1.700	49.62	27.59	3183	3.20	10.05	9137	subC
NP	14 /37	NPC	24	58.50	58.55	0.05	1.421	19.64	31.38	29.87	19.11	0.64	3261	3.61	1.584	39.05	37.17	4058	4.49	11.07	8872	subC
NP	20 /37	NPC	29	75.50	75.55	0.05	1.328	30.25	11.68	28.35	29.72	1.05	4006	1.68	1.548	16.75	40.65	5743	2.41	4.19	8243	ligA
NP	20 /37	NPC	30	76.00	76.05	0.05	1.321	28.35	11.88	28.87	30.90	1.07	4125	3.07	1.513	16.58	40.29	5757	4.28	7.44	8507	subC
NP	27 /37	NPC	37	57.00	57.05	0.05	1.395	22.23	19.65	29.54	28.58	0.97	3947	4.37	1.573	25.27	37.98	5075	5.62	11.07	9016	subC
CSH																						
NP	27 /37	NPC	36	56.00	56.05	0.05	1.667	12.69	44.92	24.97	17.42	0.70	2597	6.68	1.846	51.45	28.60	2974	7.65	25.72	9078	subC
NP	28 /37	NPC	38	86.50	86.55	0.05	1.824	10.10	57.91	18.56	13.43	0.72	2025	2.18	2.010	64.42	20.65	2253	2.42	10.77	9752	subB

thickness (meter)		assumed COAL	CSH	MDST	Total	original COAL	CSH	MDST	Total
NP	10 /36	1.68	0.32	0.05	2.05	1.68	1.83	0.00	3.51
	16 /36	1.40	0.60	0.05	2.05	1.40	0.50	0.00	1.90
	14 /37	1.70	0.30	0.70	2.70	1.70	0.30	0.65	2.65
	20 /37	1.65	0.20	0.45	2.30	1.65	0.20	0.40	2.25
	27 /37	1.70	0.30	0.05	2.05	1.70	0.20	0.00	1.90
	28 /37	1.35	0.10	1.15	2.60	1.35	0.10	1.10	2.55

		thick	as mined basis SpGr	M	ASH	VM	FC	(FR)	CV	TS	dry basis SpGr	ASH	VM	CV	TS	TSmg/kcal	ASTM class Btu/lb	Class
Nong Plab	COAL	1.58	1.334	30.00	18.59	26.38	25.03	0.95	3477	2.56	1.557	26.56	37.69	4967	3.65	7.35	7808	ligA
	CSH	0.30	1.565	25.00	43.45	18.47	13.09	0.71	1960	3.78	1.928	57.93	24.62	2613	5.04	19.29	6546	ligA
	MDST	0.41	1.807	20.00	71.68	8.32	0.00	0.00	0	0.80	2.263	89.60	10.40	0	1.00			
	ROM including OSD	2.29	1.449	27.06	33.96	21.23	17.75	0.84	2486	2.34	1.738	46.56	29.11	3408	3.20	9.40	7025	ligA
	PRODUCT		1.389	28.60	25.76	24.04	21.61	0.90	3027	2.67	1.646	36.07	33.66	4239	3.74	8.82	7515	ligA

3.3 Mae Lamao Basin

3.3.1 Geography

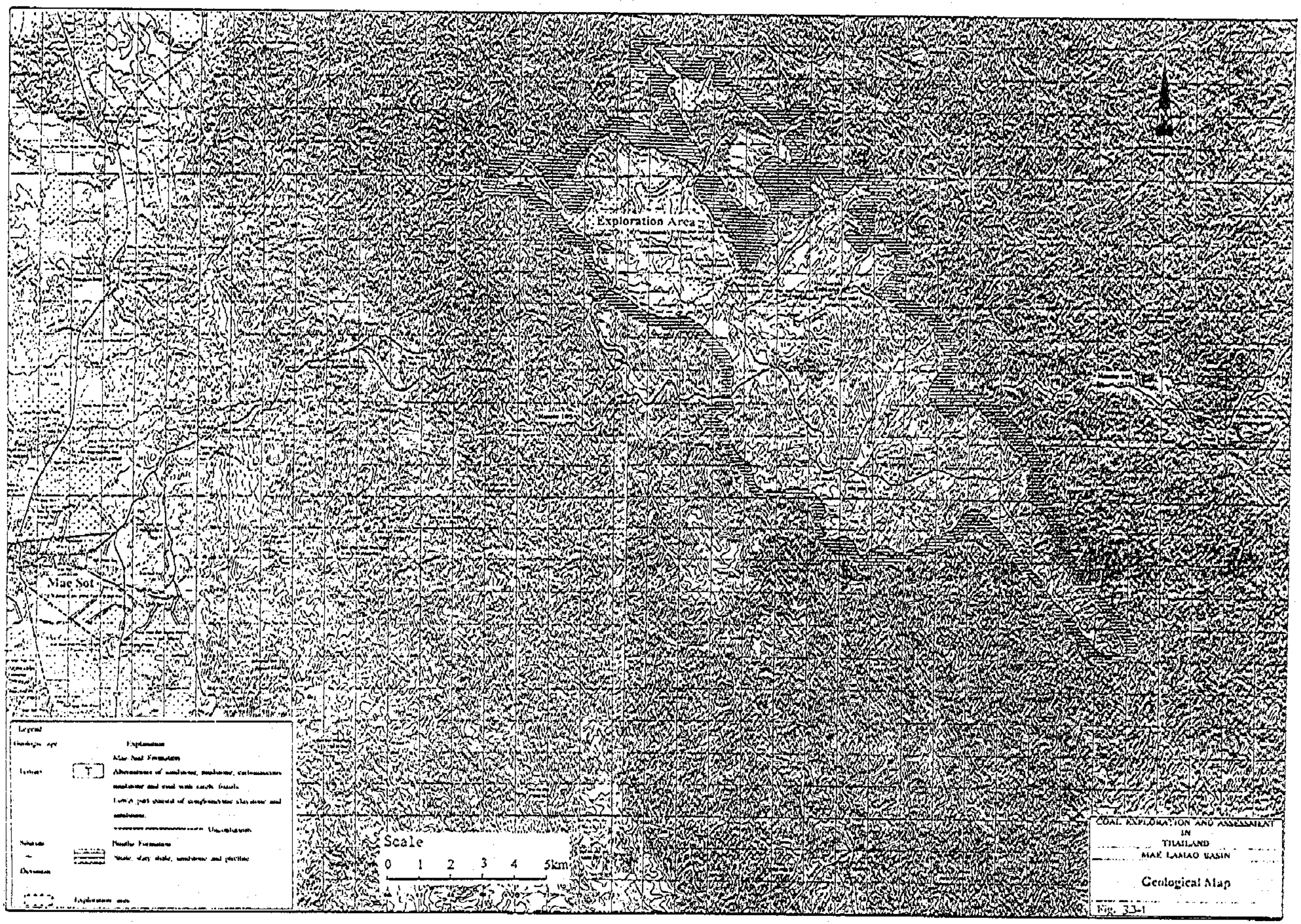
The Mae Lamao Basin is located to 55 km west of Tak and 35 km east of Mae Sot in Tak Province. National Highway No.105 connects these two towns and passes through the basin as shown in Fig.3.3-1.

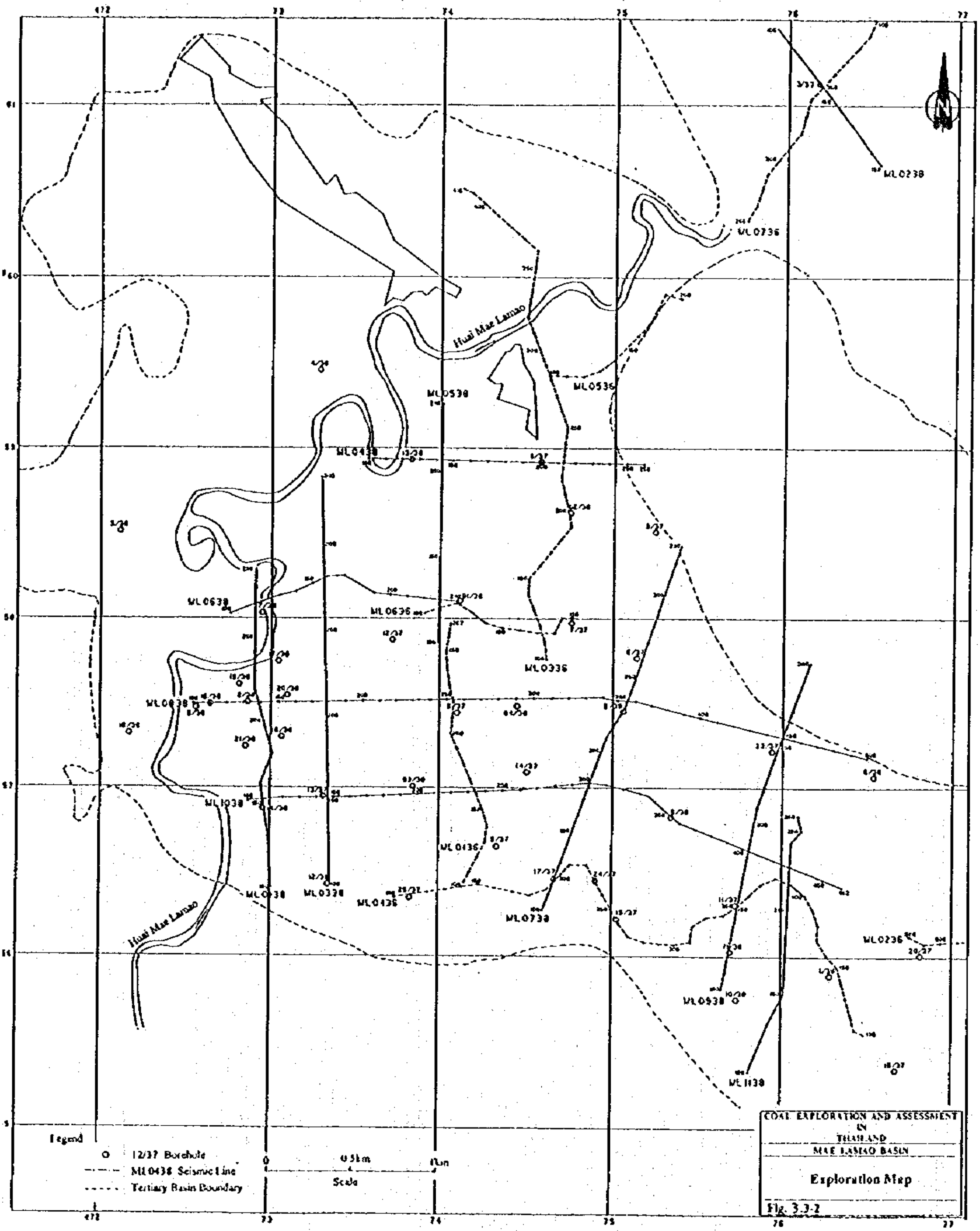
The whole basin extends to NW-SE direction covering an area of approximately 90 km². However, main exploration work was concentrated in the area of 12 km² in the northwestern part of the basin because of poor potential of coal resources in other areas. The topography of the exploration area is mostly flat land with minor gentle hills, ranging from 250 m to 350 m in altitude. The Mae Lamao River flows on the western side of the area from south to north. The surface of the area is mainly utilized for farming of corn and bean with a small portion of paddy field.

According to the weather statistics for the last ten years, temperature and rainfall observed at Mae Sot station are as follows;

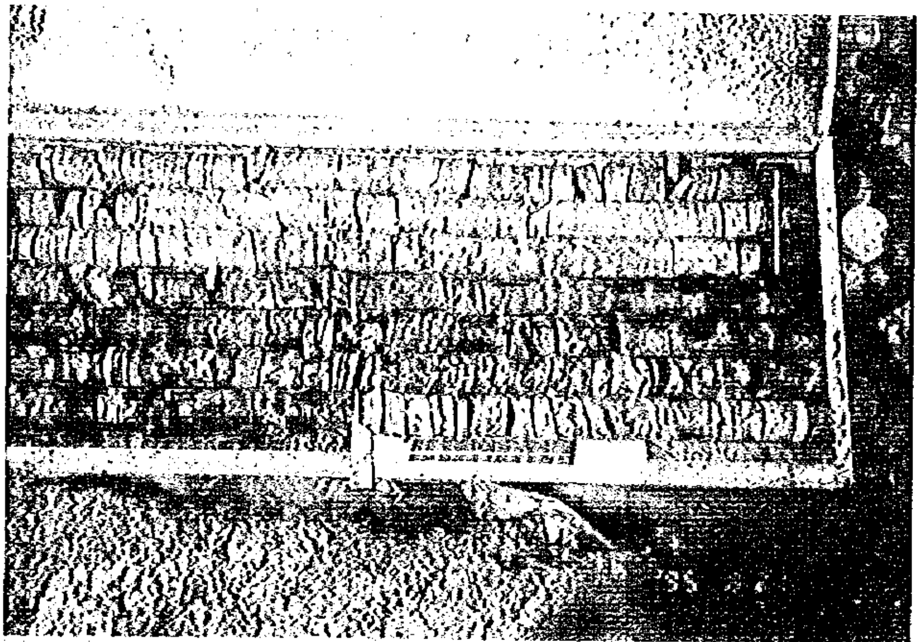
Temperature (°C)	:	mean 25.4
		mean maximum 32.4
		mean minimum 20.4
Rainfall (mm)	:	mean annual 1359.5
		monthly 1.4 (January) ~ 341.8 (July)

At the northwestern margin of the basin, an open pit coal mine, named Sujae Lignite mine, is being operated. Its annual production is not more than 100,000 t and the product coal is sent to a cement factory at Saraburi.

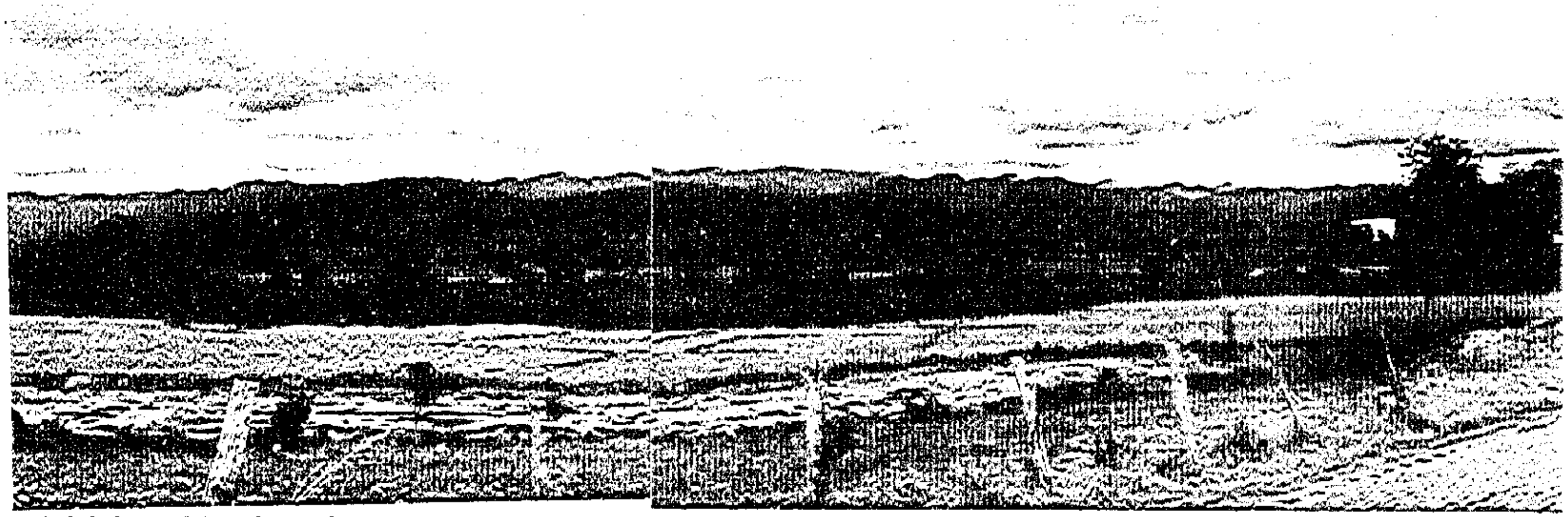

Exploration Area
Mae Sot
Legend
Explanation
Scale
0 1 2 3 4 5km
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Geological Map
Fig. 33-1


ML0238
ML0736
Hual Mae Lamao
ML0536
ML0538
ML0438
ML0638
ML0636
ML0336
ML0838
ML1038
ML0136
ML0138
ML0338
ML0436
ML0738
ML0236
ML0938
ML1138
Huai Mae Lamao
Legend
12/37 Borehole
ML0438 Seismic Line
Tertiary Basin Boundary
0
0.5km
1km
Scale
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Exploration Map
Fig. 3.3-2

Ph.33.-1 Core logging of the borehole ML16/38.



Ph.3.3-2 Upper coal bed of borehole ML16/38,174.4m



Ph.3.3-3 The view of the mine planning area.

3.3.2 Exploration and geological investigation

(1) Exploration

The following exploration was carried out by DMR in the Mae Lamao Basin.

Table 3.3-1 Exploration in the Mae Lamao Basin

		1993	1994	1995	Total
Drilling	(holes)	-	25	25	50
Total depth	(m)	-	4,690.0	3,932.7	8,622.7
Geophysical Logging	(holes)	-	8	13	21
Seismic Survey	(lines)	8	-	11	19
Total length	(km)	15.6	-	23.2	38.8
Coal Analysis	(samples)	190	-	189	379

The location of boreholes and seismic lines are shown in Fig.3.3-2 and borehole data are summarized in Table 3.3-2 and -3.

(2) Geological investigation

All of the geological data obtained from the above exploration are investigated as the following procedures;

- Cores of six boreholes are logged by the Study Team (Ph.3.3-1,-2) by means of lithofacies coding method and lithofacies logs are drafted. Lithofacies logs of MLG1/38 and 3/38 are shown in Fig.3.3-3.
- Lithologic logs of all boreholes are correlated each other at a scale of 1:400, placing a stratigraphic datum at the top of Upper Coal Bed as shown in Fig.3.3-4.
- Coal bed sections are drafted from lithologic logs and adjusted to the geophysical logs, when available. They are correlated each other on ply by ply basis as shown in Fig.3.3-5..

- Geologic structure is interpreted from the seismic and borehole data, but the seismic profiles are used only for determination of dipping direction, owing to difficulties in tracing the remarkable reflector.
- Based on the above investigation, various kinds of coal bed maps, such as an isopach map, structure contour map, are produced.
- Coal resources and reserves of the Upper Coal Bed are estimated in accordance with the standard introduced in the Study.
- All the analytical data are examined. However, many assumptions are required for estimation of product coal quality due to inadequate sampling method.

Table 3.3-2 Summary of Boreholes in the Mae Lamao Basin, 1994

Borehole No.			Elevation (m)	T.depth(m)		Basement(m)		Upper Coal Bed(m)		
				Surface	Sea level	Surface	Sea level	Coal Seam	Surface	Sea level
1	37		270.9	190.0	80.9	187.5	83.4	4.31/4.51	135.70	135.20
2	37	★	323.7	157.0	166.7					
3	37	★	254.5	447.0	-192.5					
4	37	★	324.4	248.0	76.4					
5	37		304.3	150.0	154.3	128.0	176.3	2.82/4.05	121.18	183.12
6	37		272.3	165.0	107.3					
7	37	●	268.8	312.5	-43.7			7.28/8.37	274.60	-5.80
8	37		311.4	330.0	-18.6	318.8	-7.4	7.75/10.44	238.00	73.40
9	37		268.4	25.5	242.9	18.5	249.9			
10	37	★	315.9	263.0	52.9	245.0	70.9			
11	37		302.7	250.0	52.7			1.27/22.21	151.00	151.70
12	37		279.1	206.0	73.1			5.18/12.33	163.40	115.70
13	37		275.6	341.0	-65.4			3.67/7.87	204.60	71.00
14	37	●	291.9	251.0	40.9			4.03/6.57	209.85	82.05
15	37	●	301.8	37.5	264.3	25.5	276.3			
16	37	★	329.8	219.0	110.8	210.5	119.3			
17	37	●	302.3	79.0	223.3	72.0	230.3	1.64/4.44	67.80	234.50
18	37	★	315.9	38.0	277.9	5.0	310.9			
19	37		290.2	22.0	268.2	13.5	276.7	0.37/0.50	8.30	281.90
20	37		299.1	177.5	121.6					
21	37	★	318.5	166.5	152.0	131.5	187.0			
22	37	★	341.8	300.0	41.8					
23	37		297.6	92.0	205.6	86.6	211.0	1.62/2.31	67.70	229.90
24	37	●	284.8	101.5	183.3	93.7	191.1	2.01/6.54	55.55	229.25
25	37	●	305.3	121.0	184.3	114.0	191.3	2.36/4.33	88.85	216.45
Total				4,690.0						

★ Borehole location was outside of the study area.

● Geophysical logging was performed. The depth and thickness were adjusted to the geophysical logs.

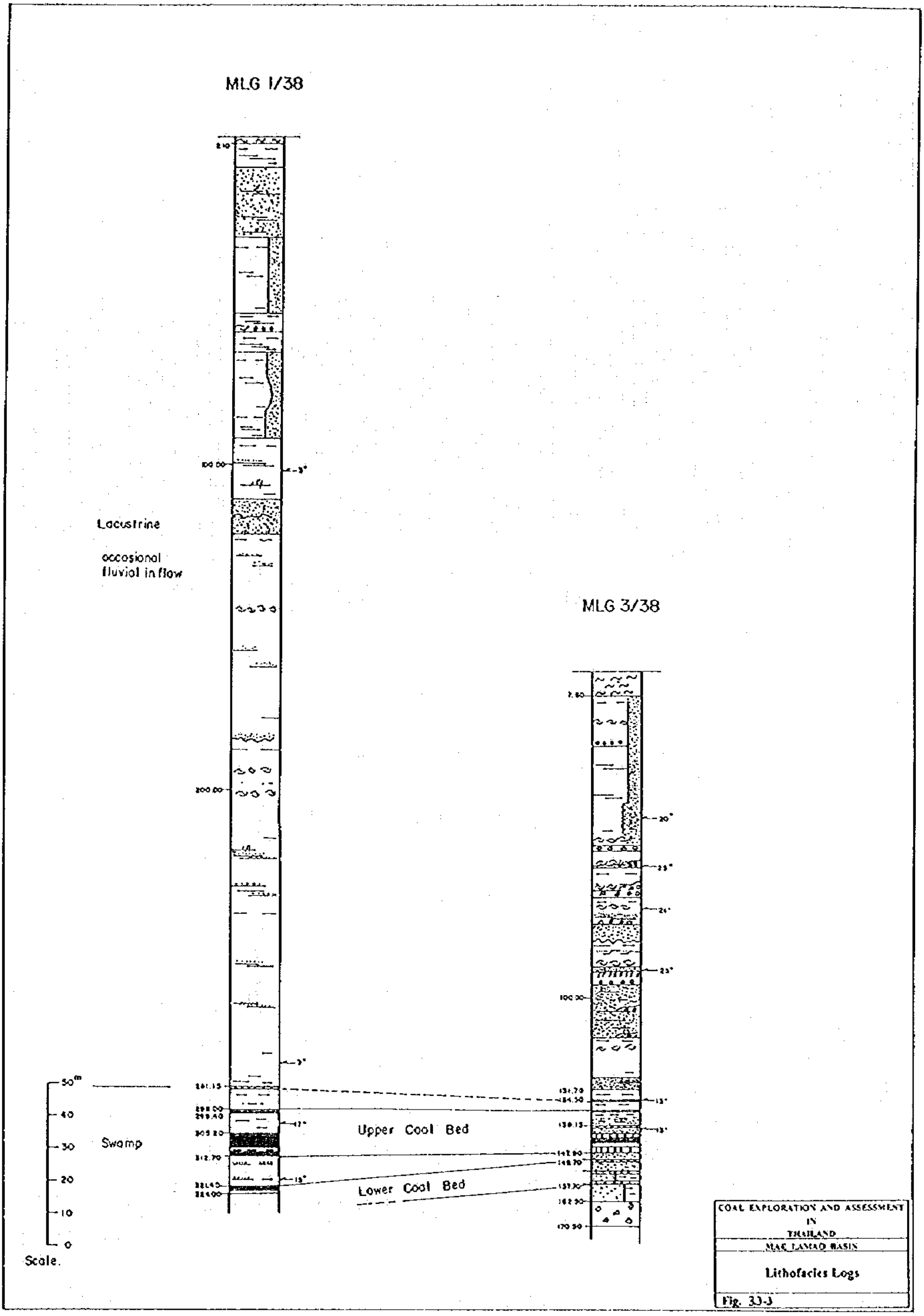
4.51/4.51 indicates the true thickness of coal bed.

Table 3.3-3　Summary of Boreholes in the Mae Lamao Basin, 1995

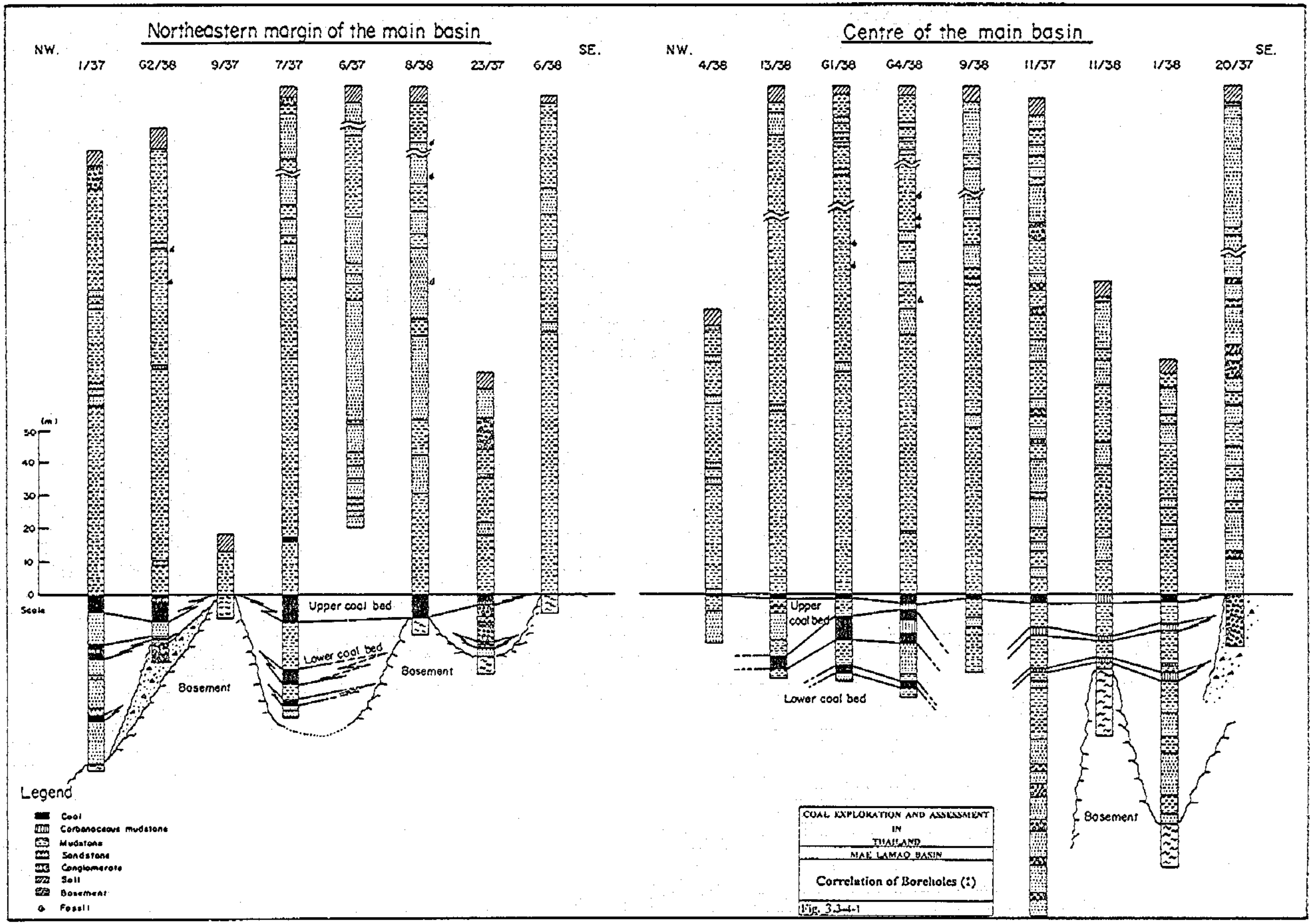
Borehole No.			Elevation (m)	T.depth(m)		Basement(m)		Upper Coal Bed(m)		
				Surface	Sea level	Surface	Sea level	Coal Seam	Surface	Sea level
1	38		294.5	156.3	138.2	141.4	153.1	1.90/25.76	71.80	222.70
2	38		260.7	152.0	108.7			8.36/9.60	132.65	128.05
3	38		270.9	128.0	142.9	122.0	148.9	·		
4	38		256.1	102.0	154.1			0.36/0.80	86.70	169.40
5	38		266.4	77.0	189.4					
6	38		290.5	158.0	132.5	151.6	138.9			
7	38		260.3	88.0	172.3			0.60/0.95	64.05	196.25
8	38	●	272.3	252.0	20.3	247.0	25.3	6.06/6.84	239.17	33.13
9	38	●	278.0	242.0	36.0			1.17+/2.35+	218.60	59.40
10	38	●	301.3	74.0	227.3	68.8	232.5			
11	38	●	294.0	139.5	154.5	118.8	175.2	0.27/19.70	95.87	198.13
12	38		286.6	201.0	85.6	189.0	97.6	1.34/11.42	134.92	151.68
13	38		260.7	222.0	38.7			4.97/23.10	195.85	64.85
14	38		267.7	102.0	165.7					
15	38	●	263.4	149.0	114.4	143.2	120.2	4,13/6.50	127.60	135.80
16	38	●	264.7	202.0	62.7			4.84/8.81	174.45	90.25
17	38		260.5	68.5	192.0	64.0	196.5	0.36/0.36	59.35	201.15
18	38		262.6	23.5	239.1	18.9	243.7			
19	38	●	261.5	110.0	151.5	101.4	160.1	4.57/7.04	94.40	167.10
20	38	●	262.2	106.0	156.2	97.1	165.1	0.75/0.75	95.60	166.60
21	38	●	266.3	239.5	26.8			4.97/10.24	200.05	66.25
G1	38	●	269.5	324.0	-54.5			5.41/13.20	298.00	-28.50
G2	38	●	270.8	163.3	107.5			5.10/7.86	142.24	128.56
G3	38	●	289.9	170.5	119.4			1.76/13.20	134.50	155.40
G4	38	●	277.2	282.6	-5.4			7.04/15.31	250.25	26.95
Total				3,932.7						

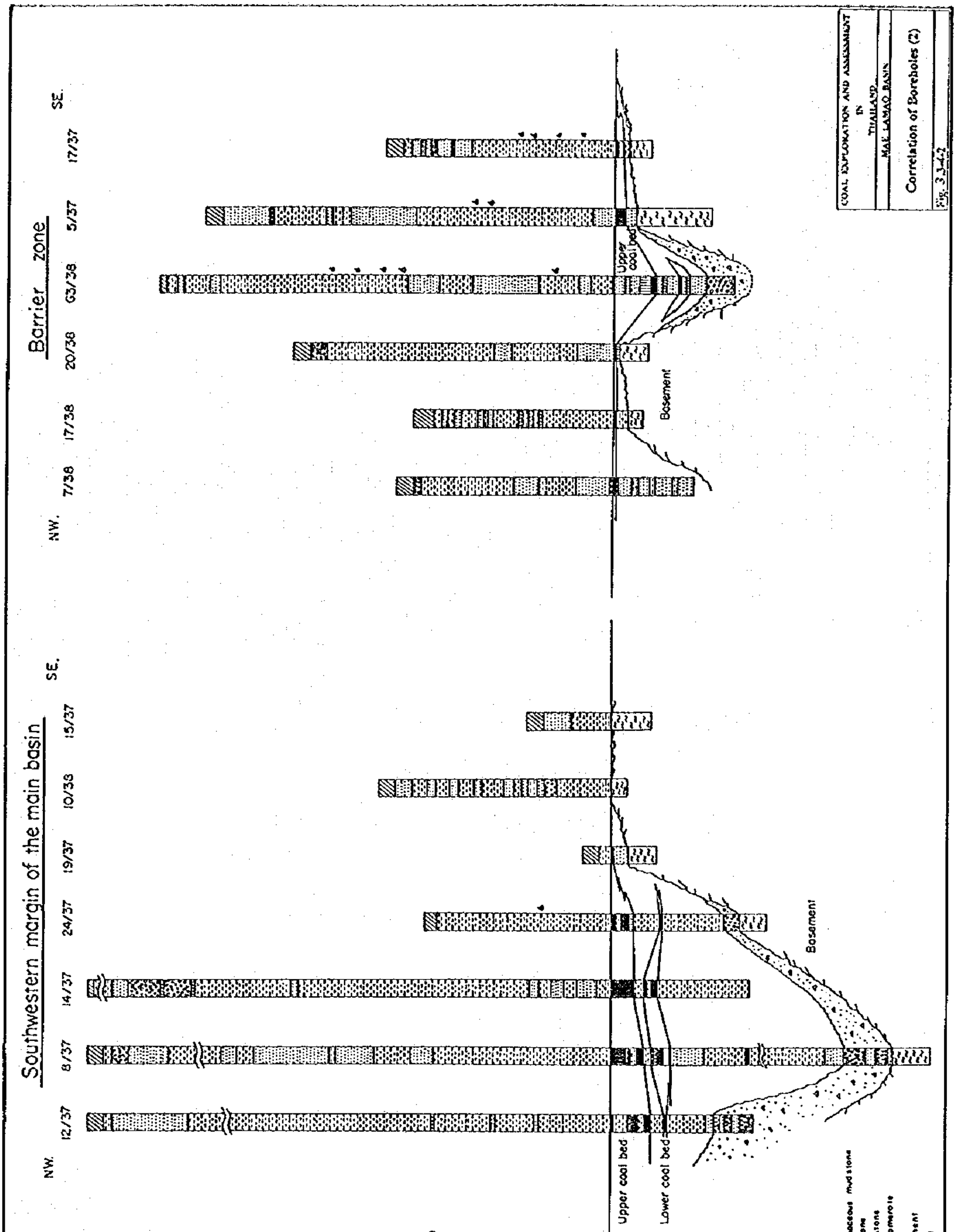
● Geophysical logging was performed. The depth and thickness were adjusted to the geophysical logs.

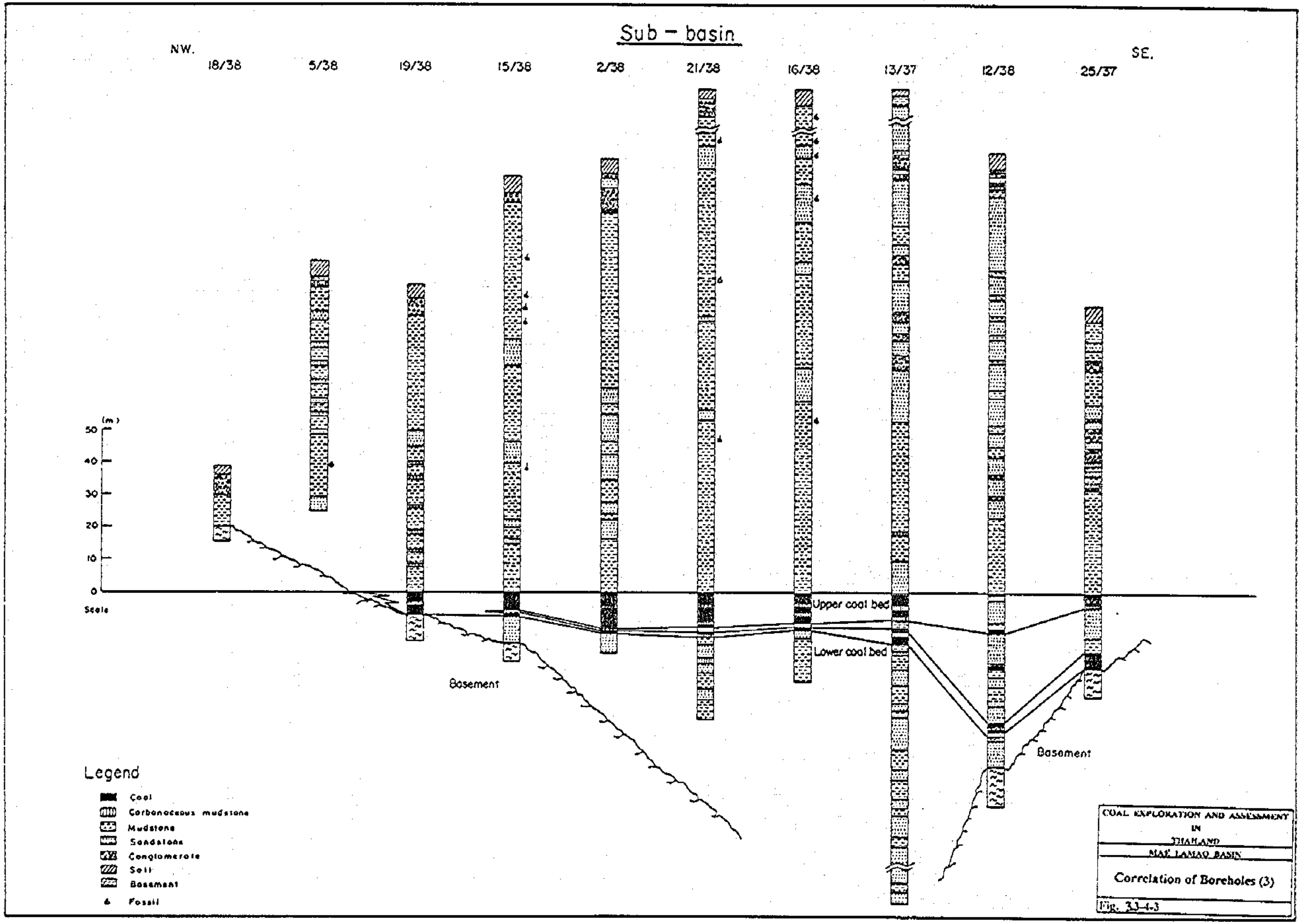
4.51/4.51 indicates the true thickness of coal bed.



COAL EXPLORATION AND ASSESSMENT IN THAILAND
MAE LAMAO BASIN
Lithofacies Logs
Fig. 33-3


Northeastern margin of the main basin
NW.
SE.
1/37
G2/38
9/37
7/37
6/37
8/38
23/37
6/38
Centre of the main basin
NW.
SE.
4/38
13/38
G1/38
G4/38
9/38
11/37
11/38
1/38
20/37
(m)
50
40
30
20
10
0
Scale
Upper coal bed
Lower coal bed
Basement
Legend
Coal
Carbonaceous mudstone
Mudstone
Sandstone
Conglomerate
Soil
Basement
Fossil
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Correlation of Boreholes (1)


Southwestern margin of the main basin
NW.
SE.
12/37
8/37
14/37
24/37
19/37
10/38
15/37
Upper coal bed
Lower coal bed
Basement
Barrier zone
7/38
17/38
20/38
G3/38
5/37
17/37
Upper coal bed
Basement
Scale
(m)
0
10
20
30
40
50
Legend
Coal
Carbonaceous mudstone
Mudstone
Sandstone
Conglomerate
Soil
Basement
Fossil
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Correlation of Boreholes (2)
Fig. 3.3-4-2



Correlation of Boreholes (3)

Fig. 3.3-4-3

3.3.3 Geology

(1) Stratigraphy

Tertiary formation of the basin is divided into the three members.

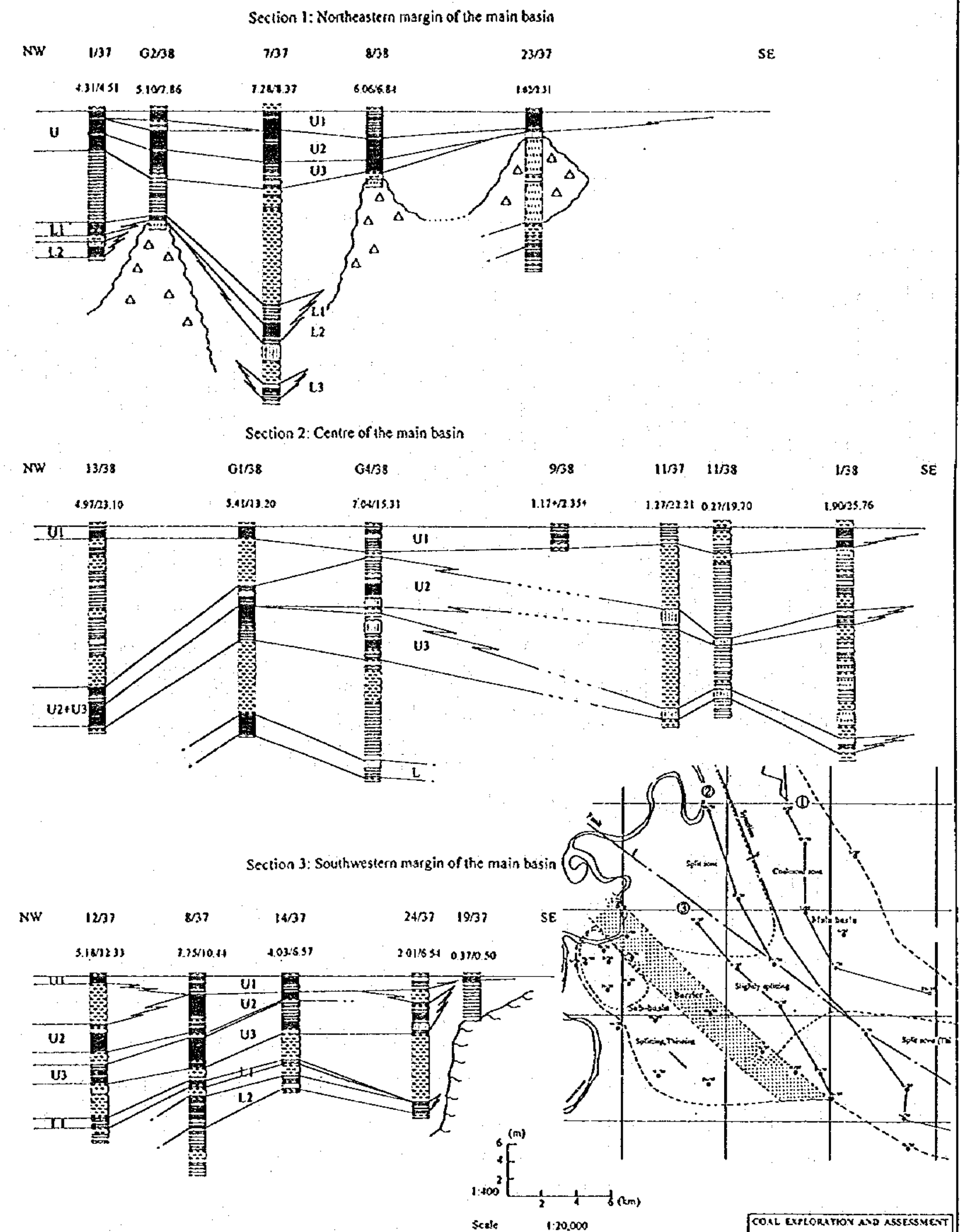
The upper member mainly consists of lacustrine mudstone with minor intercalated sandstone bands. Molluscan fossils are found throughout the member. Middle member is a coal-bearing zone. Several coal beds are present within the deposits of fine grained clastics. Splitting and coalescence of coal beds are common. The lower member consists of coarse clastics such as conglomerate and sandstone and is underlain by basement rocks unconformably. The total thickness of the Tertiary formation observed in a borehole is more than 341 m at maximum in ML13/37.

(2) Coal bed

The coal bed in the Mae Lamao Basin is fairly thick, but shows complicated features in splitting and coalescence. However, ply by ply correlation reveals a significant trend in its variation. The coal bed is subdivided into several plies, namely, U1, U2, U3 (Upper Coal Bed) and L1, L2 (Lower Coal Bed). An accumulated thickness of coal is maximum in the center of the basin as shown in Fig.3.3-6. However, the thicker single bed occurs in the northeastern part of the main basin and northwestern margin of the sub basin, where the plies of the Upper Coal Bed coalesces without thick partings. Splitting trend is observed toward southeast resulting thinning and deterioration of each coal ply. The variation and correlation of the coal bed are shown in Fig.3.3-5.

(3) Geologic structure

In general, the Mae Lamao Basin forms a broad synclinal structure, of which axis trends NW-SE direction. In the eastern limb of the syncline, the strike of the coal bed is parallel to the syncline axis with the dip of approximately 20 degrees toward west. In the western side, there is a barrier of higher basement which separates the small subbasin to west from the main basin. Two faults are presumed in the main basin which probably join to the syncline axis to the south. Structure contour of the Upper Coal Bed and geological profiles are shown in Fig.3.3-7 and Fig.3.3-8 respectively.



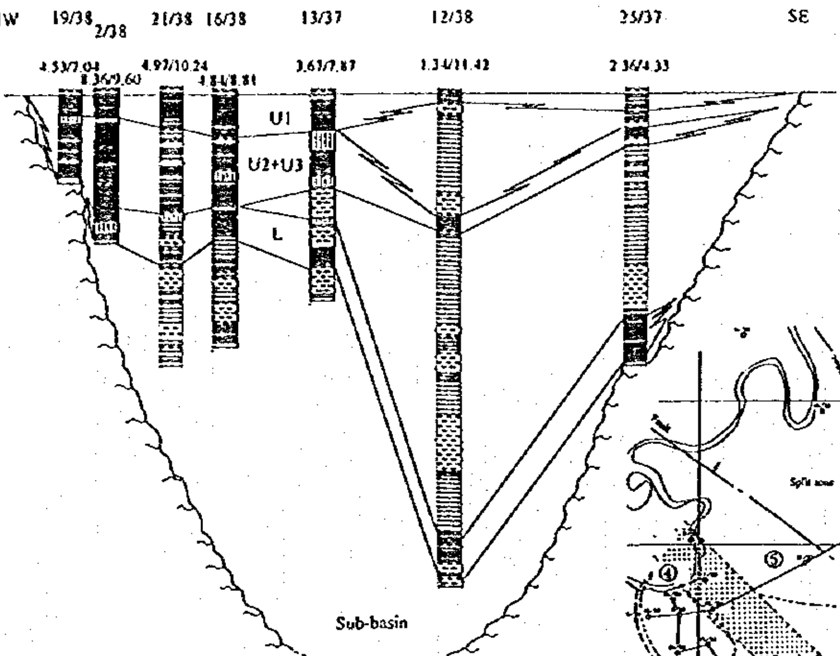
4. 31/4. 51 indicates the true thickness of upper coal bed.

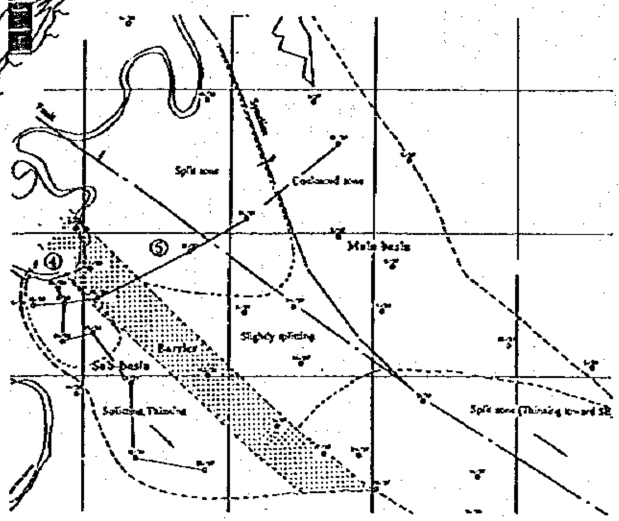
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN

Coal Bed Section (1)

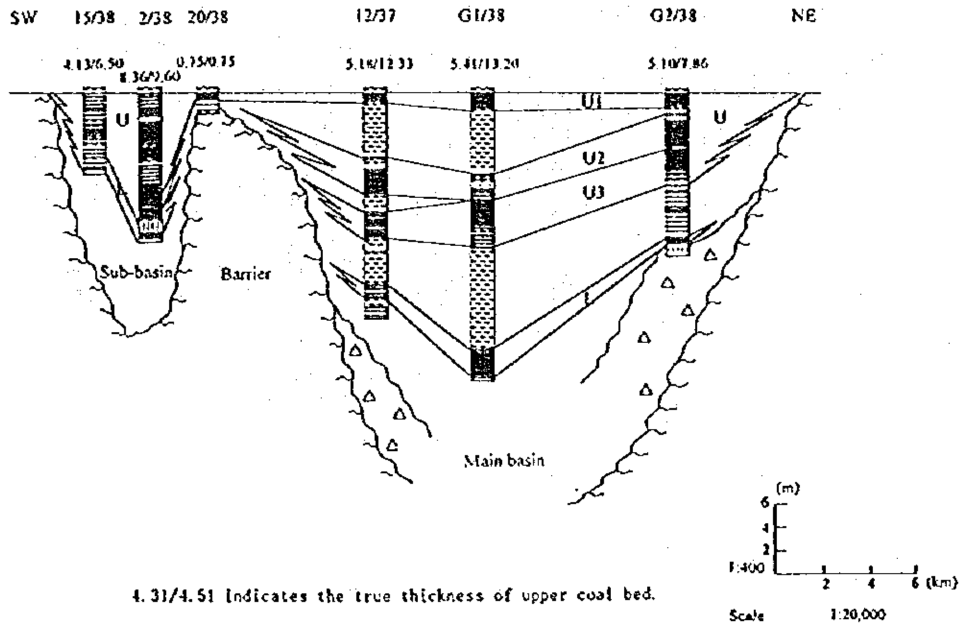
Fig. 3.3-5-1

Section 4: Centre of the sub-basin





Section 5: Short axisial direction of the nothern area



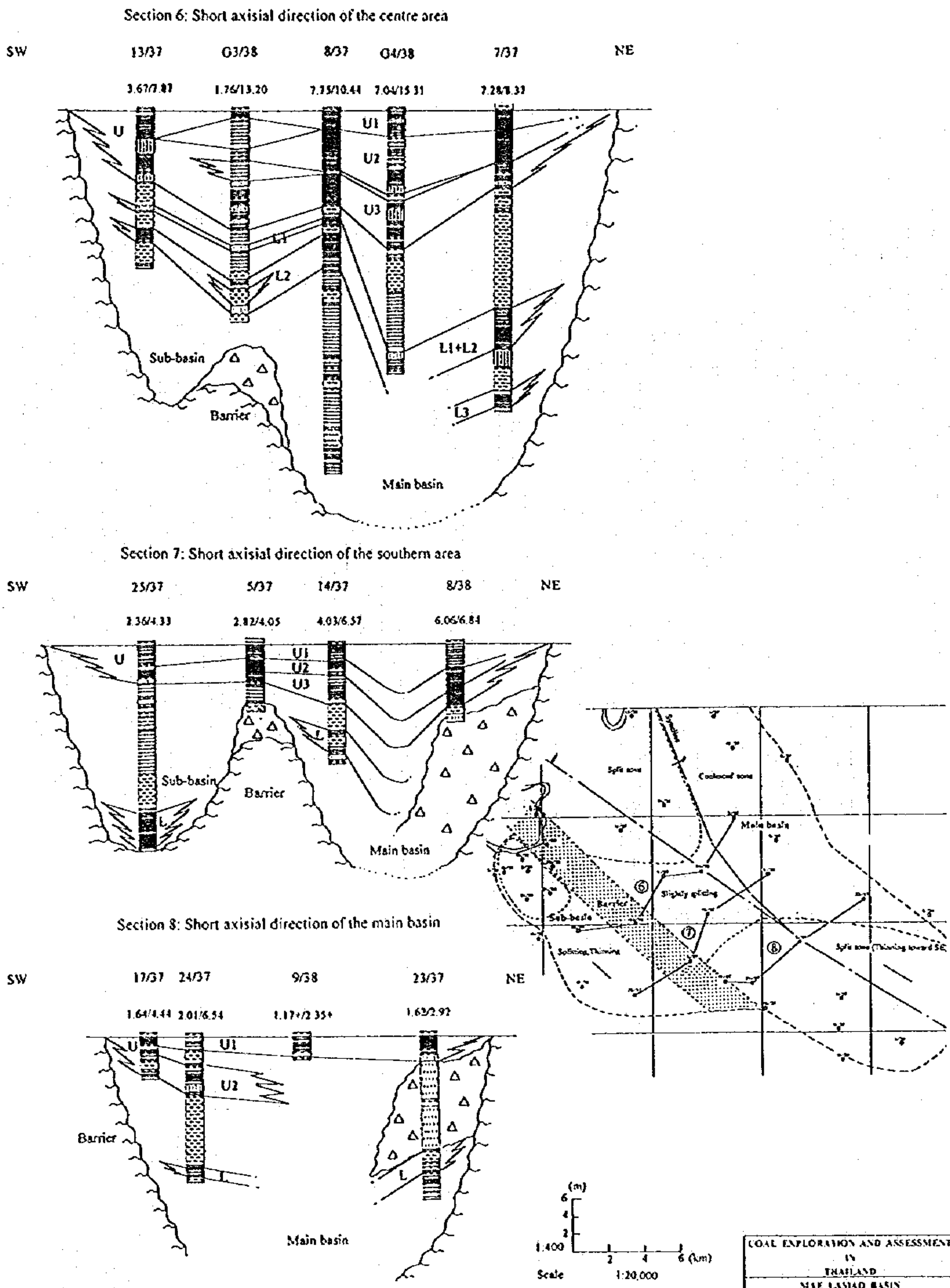
4.31/4.51 Indicates the true thickness of upper coal bed.

COAL EXPLORATION AND ASSESSMENT IN THAILAND

MAE LAMAO BASIN

Coal Bed Section (2)

Fig. 3.3-5-2



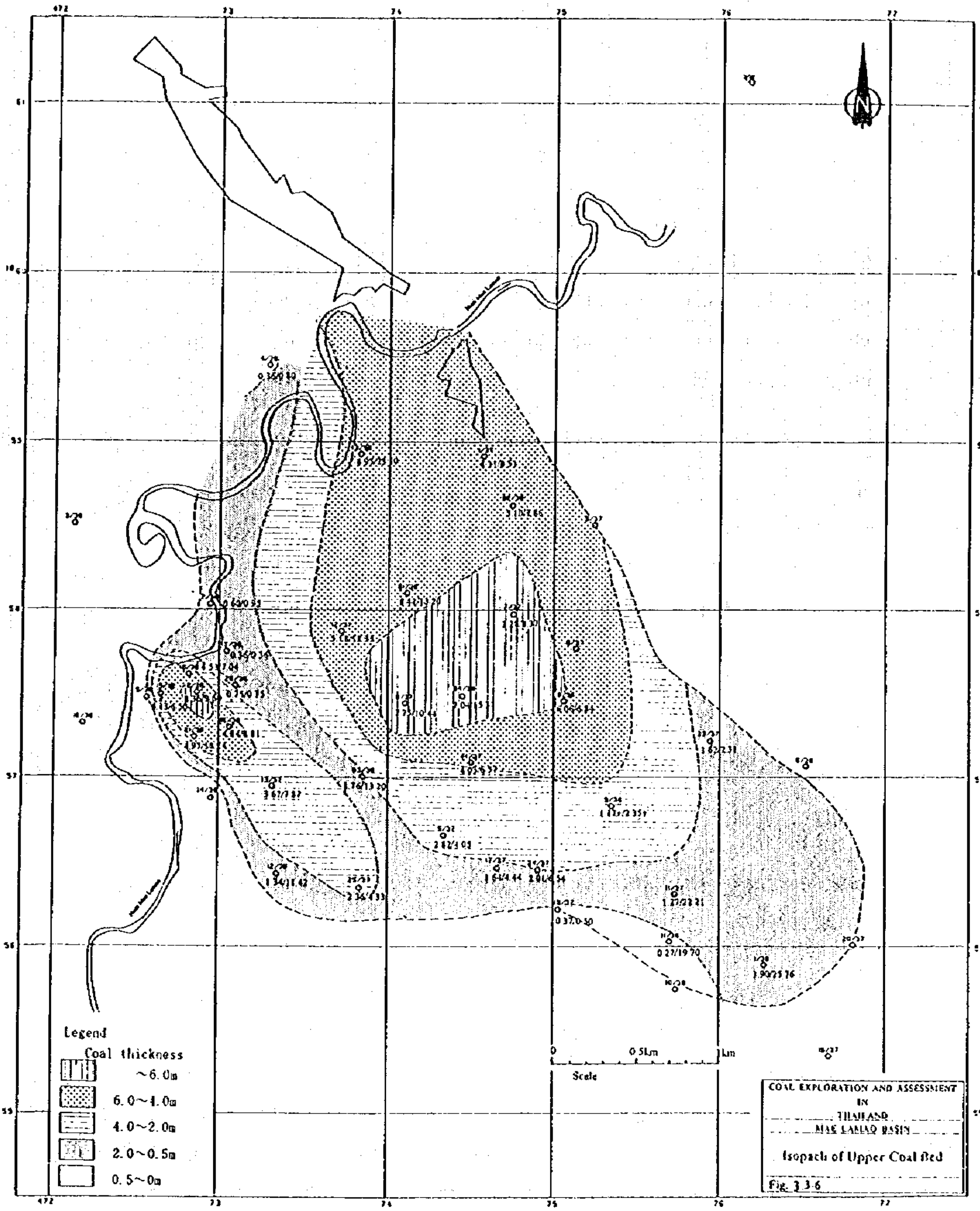
4.31/4.51 indicates the true thickness of upper coal bed.

COAL EXPLORATION AND ASSESSMENT IN THAILAND

MAE LAMAO BASIN

Coal Bed Section (3)

Fig. 3.3-5-3



Legend
Coal thickness
~6.0m
6.0~4.0m
4.0~2.0m
2.0~0.5m
0.5~0m
0
0.5km
1km
Scale
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Isopach of Upper Coal Bed
Fig. 3.3.6

(4) Sedimentary environment

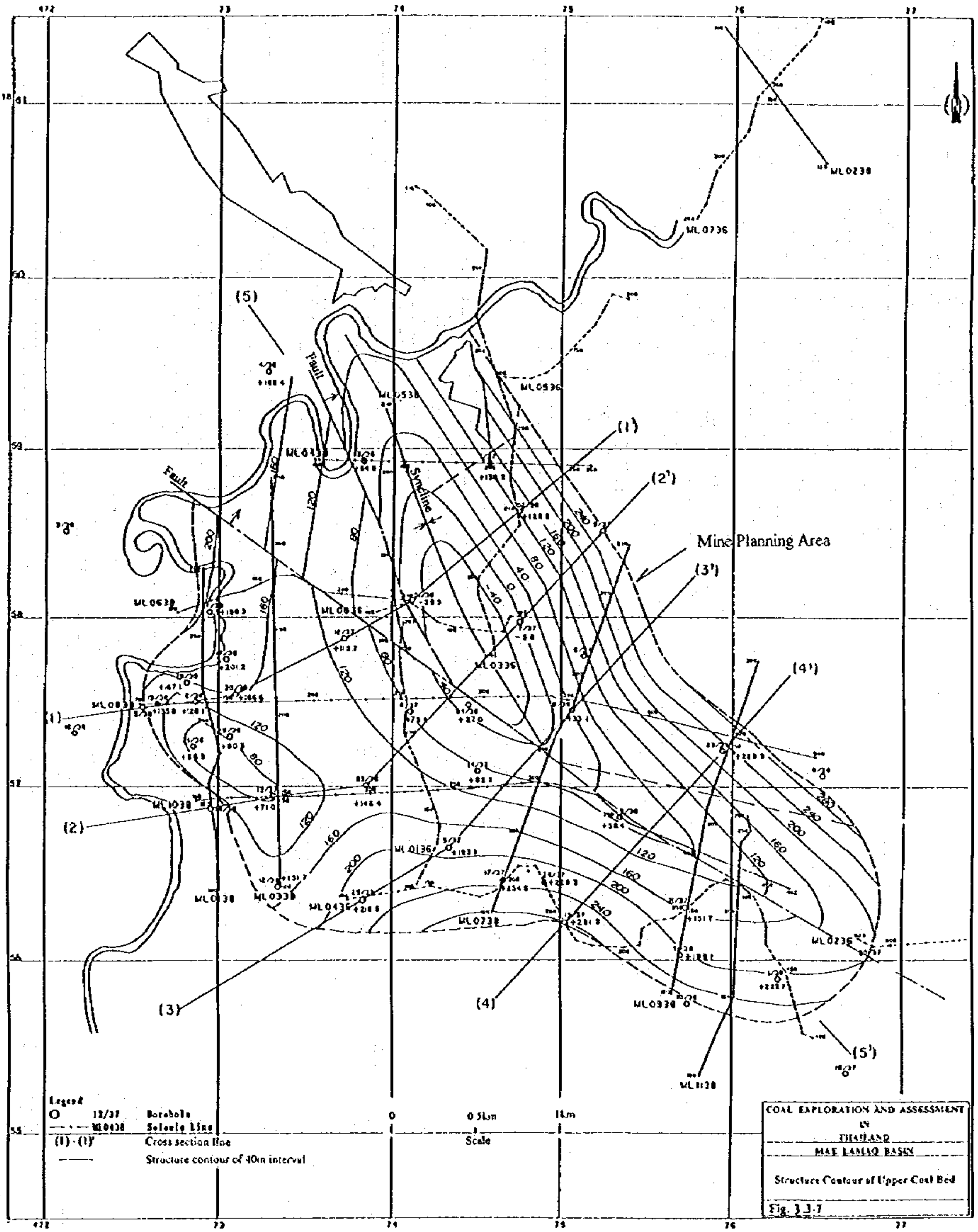
Stratigraphy of the basin indicates similarity to the typical coal-bearing formation in Thailand, i.e., A :coarse clastic member, B: coal-bearing member and C: lacustrine fine clastic member in ascending order. Different from graben origin of most of the coal basins in Thailand, however, the coal-bearing formation of this area seems to abut to basement rocks without any significant fault, indicating its deposition in a tectonic subsided area. Occurrence of coal beds also indicates similarity to those of already developed coal basins such as Li Basin, where the thicker coal beds were deposited in the confined areas in the basin. The confined areas are mostly marginal area of the basin, where subsidence of the basin was slow enough for peat accumulation with restricted inflow of clastics which hamper environment of peat deposition.

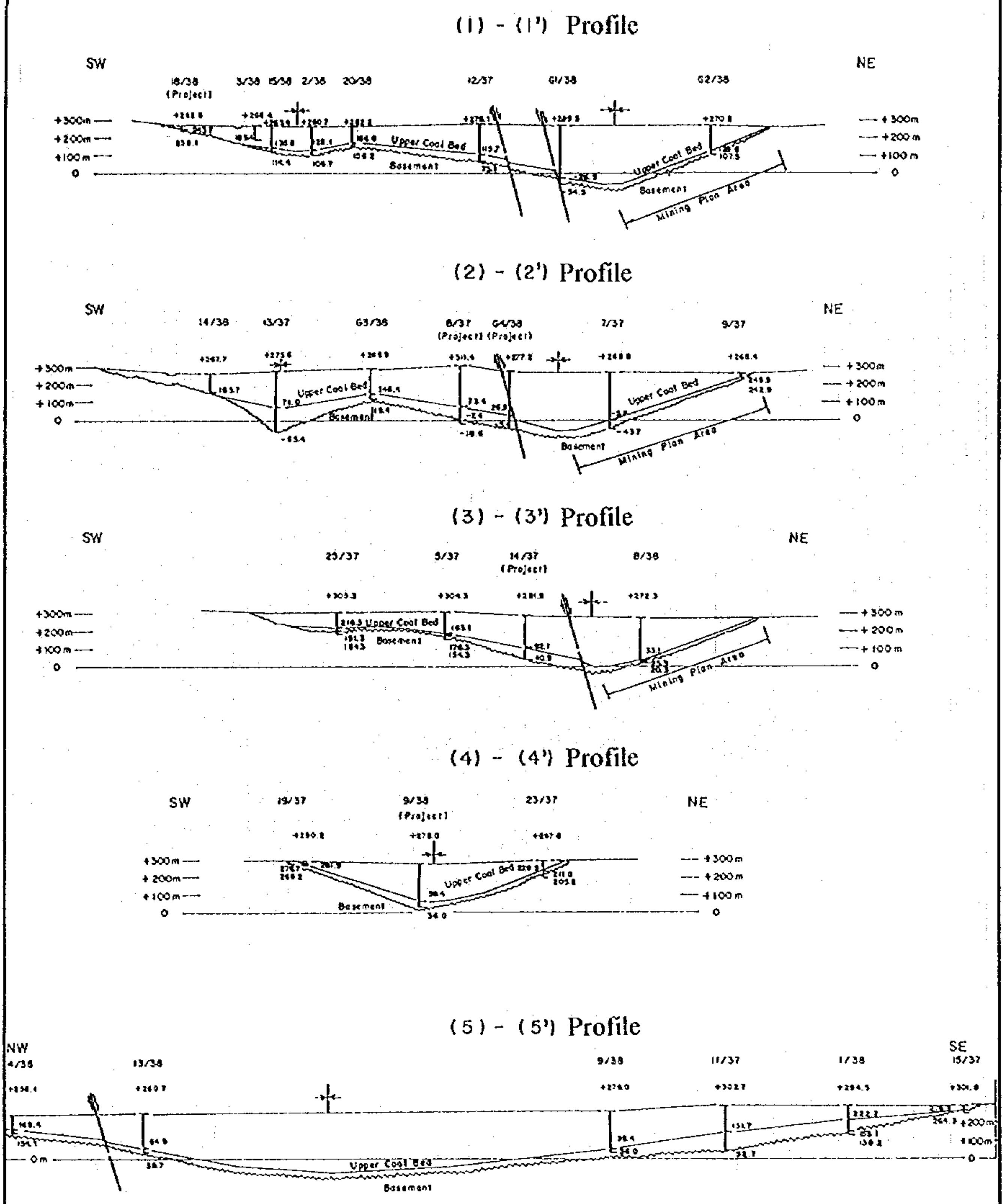
The thicker coal beds in the Mae Lamao Basin also occur in the northeastern periphery of the main basin and in the northwestern periphery of the sub basin, where the Upper Coal Bed has significant thickness, but it splits to U1, U2 and U3 toward the center and southeast or northwest from MLG4/38 in the main basin and toward southeast in the sub basin as shown in Fig.3.3-5.

From splitting of the coal beds, the subsidence of the main basin is presumed mainly toward the long axis of syncline of the basin with accompanying tilting to SE and NW centering MLG4/38. That of the subbasin is presumed toward southeast.

A barrier zone occurs between the main basin and subbasin, where the borehole penetrated the basement rocks or conglomerate, and thin coal beds were cored on the barrier at ML20/38.

The eastern side of the barrier, the Upper Coal Bed which splits toward the center of the main basin seems to coalesce again toward the basin. Splitting toward southeast suggests tilting of the basin which caused either too fast subsidence to accumulate thicker peat or dominant inflow of clastics to hamper sedimentary environment of peat. The main basin seems to tilt toward northwest from MLG4/38, but only a few boreholes drilled in the exploration area make it impossible to interpret more.


Mine Planning Area
Fault
Fault
Syncline
(1)
(1')
(2)
(2')
(3)
(3')
(4)
(4')
(5)
(5')
ML0238
ML0736
ML0536
ML0538
ML0338
ML0638
ML0838
ML0336
ML1038
ML0136
ML0138
ML0438
ML0738
ML0236
ML0938
ML1138
Legend
12/37 Borehole
ML0638 Seismic Line
(1)-(1') Cross section line
Structure contour of 40m interval
0 0.5km 1km
Scale
COAL EXPLORATION AND ASSESSMENT IN THAILAND
MAE LAMAO BASIN
Structure Contour of Upper Coal Bed
Fig. 3.3.7



COAL EXPLORATION AND ASSESSMENT IN THAILAND MAE LAMAO BASIN

Geological Profile

Fig. 3.3.8

(5) Coal resources and reserves

The coal resources of the Mae Lamao Basin, as well as coal reserves, are estimated in accordance with the standard described in 3.1.3 (5).

1) Resources

In situ coal resources of the Upper Coal Bed are estimated for each structural block and for each area divided by isopach lines.

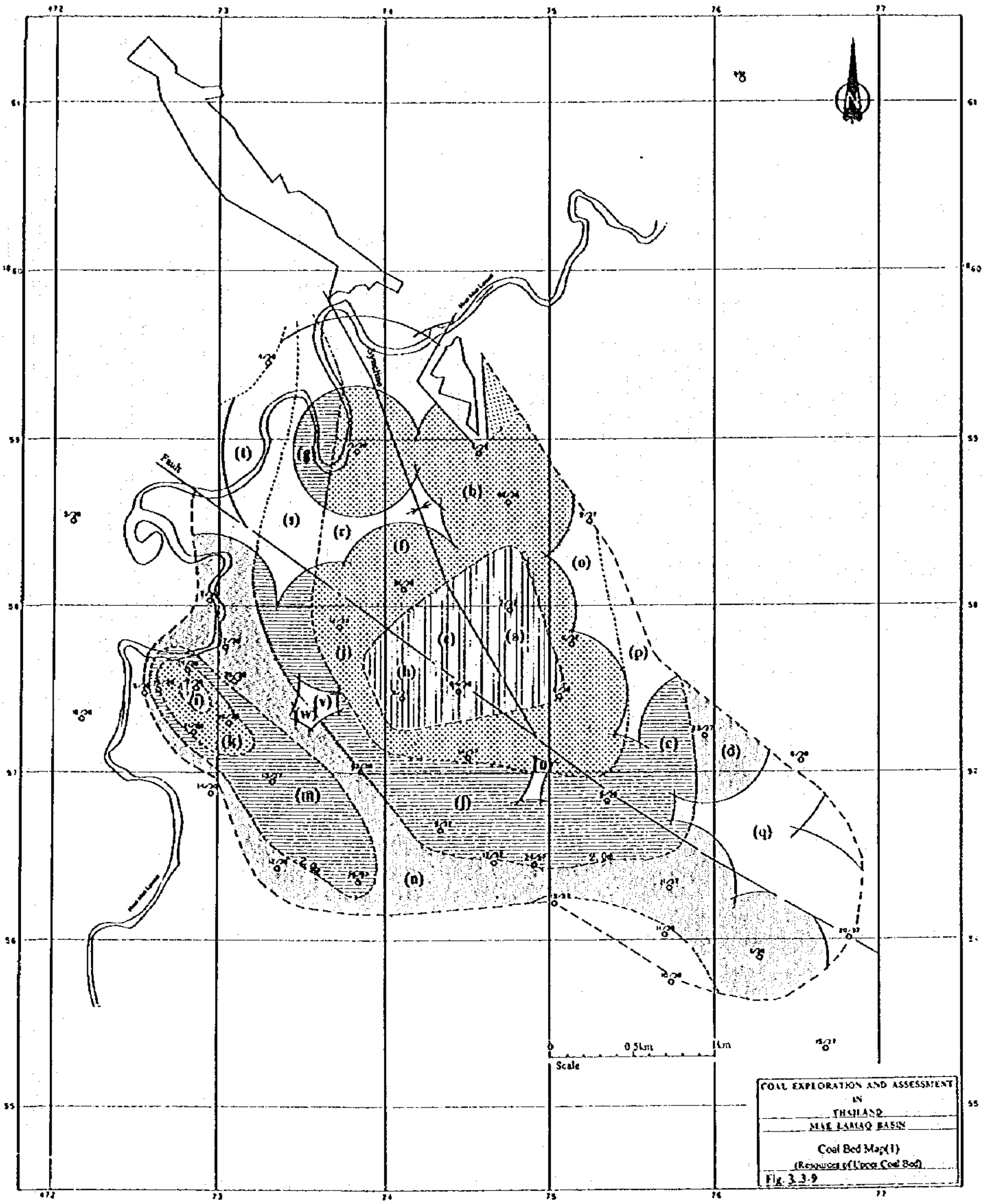
The criteria used for the estimation are same as those for the Nong Plab Basin.

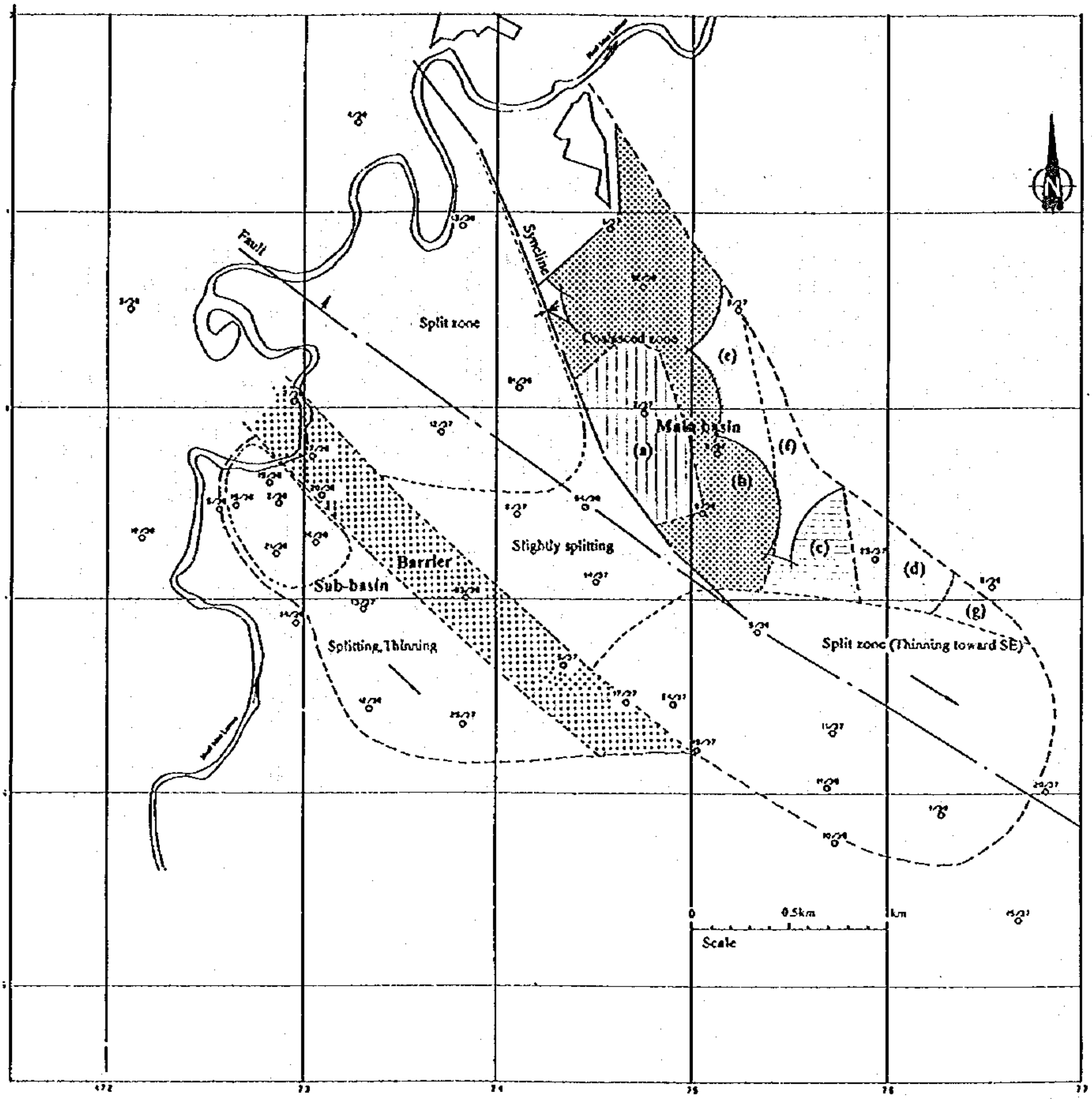
A total coal resources of the Upper Coal Bed is estimated at 44,756,000 t, of which measured and indicated resources are 36,792,000 t as shown in Table 3.3-4 and illustrated in Fig.3.3-9.

2) Reserves

According to the standard introduced in this study, only the area of eastern limb of the main syncline axis is selected for reserve estimation. The north and south of the area are limited by an old open pit mine and splitting line of the coal bed respectively.

The coal reserves in the Mae Lamao Basin are estimated at 13,993,000 t, which includes inferred reserves of 2,392,000 t as shown in Table 3.3-5 and illustrated in Fig. 3.3-10.


COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Coal Bed Map(1)
(Resources of Upper Coal Bed)
Fault
Syncline
Scale
0
0.5km
1km
Fig. 3.3-9



COAL EXPLORATION AND ASSESSMENT IN THAILAND

MAE LAMAO BASIN

Coal Bed Map(2)
(Reserves of Upper Coal Bed)

Fig. 3.3-10

Table 3.3-4 Coal Resources of Upper Coal Bed

Area	Block	Thickness (m)	Plan (1,000m2)	Dip (°)	Resources (1,000t)
Measured+Indicated					
Northeastern of Syncline	(a)	7.00	374	22	3,670
	(b)	5.00	1,144	22	8,019
	(c)	3.00	310	17	1,264
	(d)	1.25	239	19	410
Syncline to Fault	(e)	7.00	242	5	2,210
	(f)	5.00	590	9	3,882
	(g)	3.00	132	9	521
Southwestern of Fault	(h)	7.00	266	10	2,457
	(i)	8.00	21	5	219
	(j)	5.00	458	10	3,022
	(k)	5.00	166	10	1,095
	(l)	3.00	1,104	10	4,372
	(m)	3.00	627	10	2,483
	(n)	1.25	1,920	10	3,168
Total		3.62	7,593	14	36,792
Inferred					
Northeastern of Syncline	(o)	5.00	416	22	2,916
	(p)	3.00	176	22	740
	(q)	1.25	526	19	904
Syncline to Fault	(r)	5.00	173	9	1,138
	(s)	3.00	282	9	1,113
	(t)	1.25	301	9	495
Southwestern of Fault	(u)	5.00	11	10	72
	(v)	3.00	97	10	384
	(w)	1.25	123	10	202
Total		2.79	2,105	16	7,964
Grand total		3.44	9,698	14	44,756

Specific gravity : 1.3

Table 3.3-5 Coal Reserves of Upper Coal Bed

Area	Block	Thickness (m)	Plan (1,000m2)	Dip (°)	Resources (1,000t)
Northeastern of Syncline					
Measured+Indicated	(a)	7.00	374	22	3,670
	(b)	5.00	980	22	6,870
	(c)	3.00	177	19	730
	(d)	1.25	193	19	331
Total		4.64	1,724	22	11,601
Inferred	(e)	5.00	217	22	1,521
	(f)	3.00	175	22	736
	(g)	1.25	79	19	135
Total		3.50	471	22	2,392
Grand total		4.40	2,195	22	13,993

Specific gravity : 1.3

3.3.4 Mining plan

A conceptual mining plan is studied for the Upper Coal Bed of the Mae Lamao Basin. Since the coal bed occurs in shallow part of the mining plan area, a combination of openpit and underground mines is planned as outlined below. General layout of both mines are illustrated in Fig.3.3-11.

(1) Basic conditions

1) Mining plan area

The eastern side of the main syncline axis is selected for mining plan area, where the plies of the Upper Coal Bed coalesce to a thick single bed within shallow depth. The southern part of the area, however, is excluded owing to splitting and thinning of the coal bed.

2) Mining method

The coal reserves near the surface is allocated to an open pit mine which will be operated at first stage. After the completion of the open pit operation, an underground mine will be developed by means of in-seam slopes to be driven from coal bed exposure on the final wall of the openpit mine. Semi-mechanized longwall mining is applied in the same way as in the Nong Plab Basin.

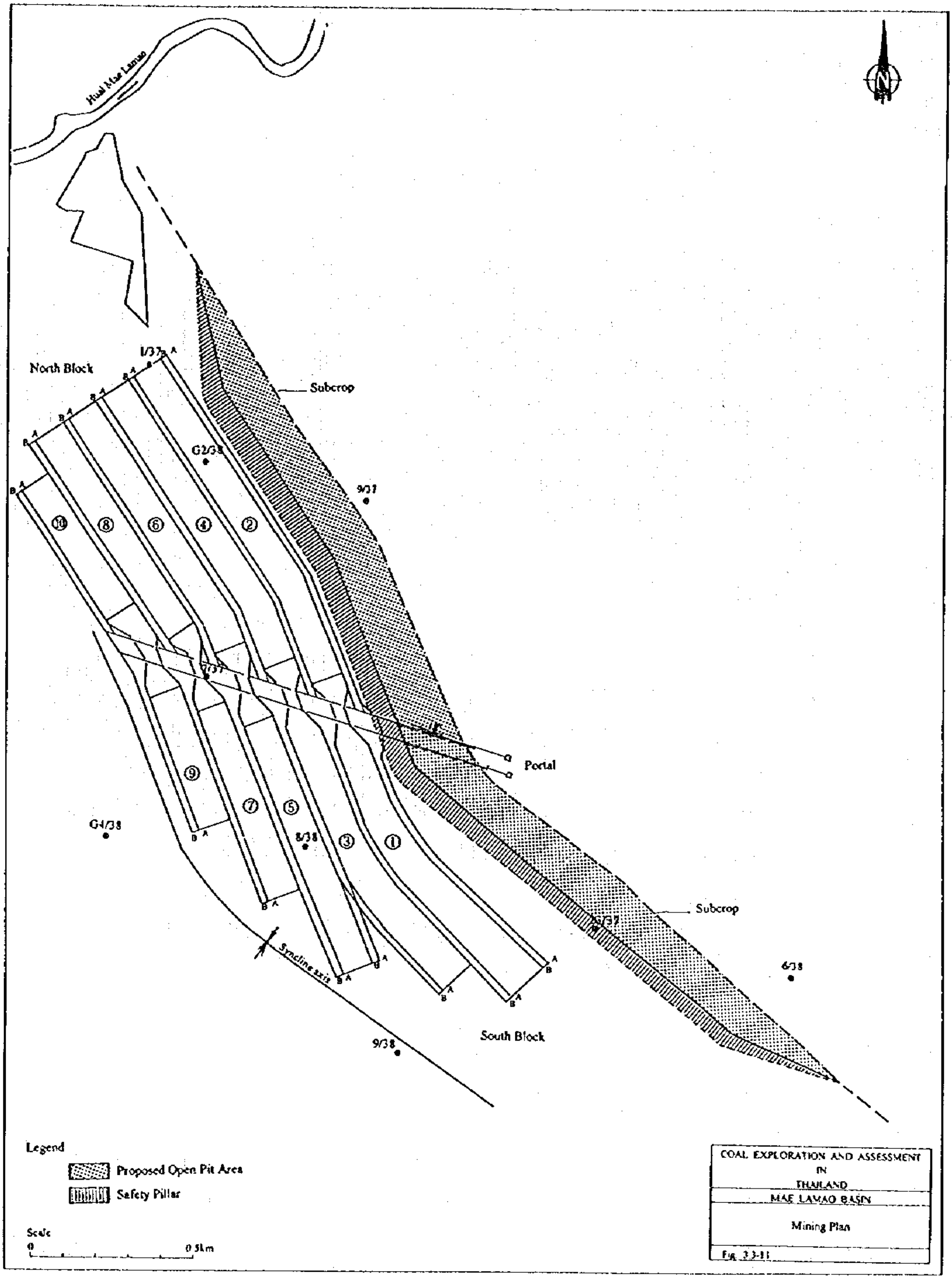
3) Mining thickness

The thickness of the Upper Coal Bed in the mine planning area ranges from 7.07 m to 2.31 m. Mining thickness adopted in this study is full-seam thickness for openpit mining and 2.5 m from the roof for longwall mining.

4) Mineable reserves

On the basis of the mining plan, mineable reserves are estimated for openpit and underground areas respectively. The values used for the parameters in the estimation formula are as follows;

Mining area : Measured on the mining plan. For openpit area, the area shallower than 10 m from the surface is excluded owing to the uncertainty of the sub crop location and possible weathering of the coal bed.


Huai Mae Lamao
North Block
South Block
Subcrop
Subcrop
Portal
Syncline axis
I/37
G2/38
9/37
7/37
G4/38
8/38
6/38
9/38
Legend
Proposed Open Pit Area
Safety Pillar
Scale
0
0.5km
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Mining Plan

Mining thickness: Openpit - 5.36 m, an average of full seam thickness at five boreholes

Underground - 2.5 m from the top

Mining recovery: 95% for both open pit and longwall mining

Specific gravity: 1.43

The estimated mineable reserves for proposed open pit and underground mines are as follows;

Open pit: 2,549,000 t

An overburden volume to be removed to extract the open pit mineable reserves is estimated 18,835,000 m^3, which makes a stripping ratio of 7.39 bcm/t raw coal.

Underground: 3,183,000 t, of which 2,700,000t is from longwall panels.

(2) Mining system

1) Open pit mine

In the eastern margin of the basin, open pit mining is proposed for the shallow part of the coal bed. The mining operation is planned by multiple bench system with such mobile equipment as bulldozers, front-end loaders, back-hoes, and dump trucks. Blasting is not required for overburden removal due to its soft characteristic. The depth of the final pit bottom is approximately 60 m from the surface. It should be noted that no bore hole was drilled within the proposed open pit area as yet. Since the area has a high potential for open pit operation, detailed exploration by means of shallow boreholes is recommended, in order to confirm the subcrop location and thickness and quality of the coal bed.

2) Underground mine

a) Mine development

The underground mine is developed through two in-seam slopes, main and sub-main, which will be opened at the exposure of the coal bed on the final wall of the open pit mine. Box or arch-shaped culverts are installed on the ground of mined out area of the open pit from the portals and then buried in order to prevent possible slumping of the high wall. The main slope is used for intake of fresh air, transportation of workers and materials and winding up mined coal and rock, while the sub-main slope is used for exhaust of polluted air. Inclination of both slopes are 18 degrees.

On both sides of the slopes, five longwall panels are planned. The gate roads of the northern area are directly connected to the slopes, while in the southern area, bypasses are driven in the rock above and below the slopes in order to prevent spontaneous combustion and damage to the slopes.
A safety barrier of not less than 100 m wide is left unmined between open pit bottom and shallowest longwall panel.

b) Roadway driving

All roadways are driven in a pair with the following standard;

Distance between the pair : 50 m - slopes
25 m - gate roads

Size of a section : 5 m x 4 m x 2.5 m

Roof support : three pieces of steel bars.

Coal and rock is broken by blasting and loaded into mine cars by a side-dump loader.

c) Longwall mining

Semi-mechanized longwall mining is designed as follows;

Panel size : 100 m x 430~1100 m

Roof support : hydraulic props with steel link bars at intervals of 0.6 m

Coal is broken by blasting and loaded onto a chain conveyor which is equipped along a working face.
A safety pillar with a distance of not less than 30 m is to be left between the final working face and the slopes.

d) Transportation

Mined coal is transported from the working face to the surface by the following means;

Working face - lower gate A : chain conveyor

Lower gate B - main slope : mine cars pulled by a battery locomotive

Main slope - surface : mine cars winded up with rope

(3) Coal production

1) Open pit mine

Annual coal production from the proposed open pit mine has been supposed to be 200,000 t in this study, which means that mineable reserves of about 2.5 million tons sustains over 12 years' open pit operation.

2) Underground mine

Coal production from the proposed underground mine has been estimated on the following basis;

Working days: 3 shifts/day, 250 days/year

Number of working teams per shift :

Longwall: 1 team

Roadway: 4 teams before commencement of L/W mining, afterward 1 team

Production rate : Longwall 100 m/day → 410 t/day

Roadway 5 m/day → 100 t/day

3 m/day → 60 t/day (slope)

On the above basis, a production schedule through the 28 years' mine life is planed as shown in Table 3.3-6. A typical annual production tonnage is shown below;

1st year : 51,000 t development only

2nd 19th year : 120,000 t longwall + development

20th 28th year: 100,000 t longwall only

3) Work force

At full production period, the following work force is required for open pit and underground mines respectively.

a) Open pit mine

	Workers	Staff	Total
Direct	87	7	94
Indirect	34	28	62
Total	121	35	156

The above number of workers includes allowance for attendance rate of 90 %.

b) Underground mine

	Workers	Staff	Total
Direct	161	27	188
Indirect	191	73	264
Total	352	100	452

The above number includes allowance for attendance rate of 85% for direct workers and 90% for indirect workers.

Table 3.3-6 Production Schedule - Mae Lamao U/G Mine

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
Roadway																													
Dev.(m)	2,600	3,955	1,250	1,250	590	1,050	1,250	1,250	1,145	480	1,250	1,250	1,131	504	1,250	1,250	779	1,120	900										
Prod.(t)	51,308	78,047	24,667	24,667	11,643	20,720	24,667	24,667	22,595	9,472	24,667	24,667	22,319	9,945	24,667	24,667	15,372	22,102	17,760										478,619
L/W Pannel																													
S-1:①		38,950	102,500	102,500	56,618																								300,568
N-1:②					45,920	102,500	102,500	102,500	18,469																				371,889
S-2:③									84,050	102,500	102,500	11,518																	300,568
N-2:④												91,020	102,500	102,500	35,114														331,134
S-3:⑤															67,240	102,500	102,500	18,139											290,379
N-3:⑥																		84,460	102,500	102,500	16,203								305,663
S-4:⑦																					86,100	102,500	33,854						222,454
N-4:⑧																							68,470	102,500	100,730				271,700
S-5:⑨																									1,640	102,500	41,899		146,039
N-5:⑩																											60,680	100,642	161,322
Total																													
Prod.(t)	51,308	116,997	127,167	127,167	114,181	123,220	127,167	127,167	125,114	111,972	127,167	127,205	124,819	112,445	127,021	127,167	117,872	124,701	120,260	102,500	102,303	102,500	102,324	102,500	102,370	102,500	102,579	100,642	3,180,335

(4) Cost estimation

Capital and operating costs for the mining plan are roughly estimated as same way as the Nong Plab Basin. A summary of the results is as follows. The details are explained in Appendix 3.

1) Open pit mine

a) Capital cost (Initial)

		(US$)
Surface facilities and equipment	:	2,800,000
Mining equipment	:	3,600,000
Vehicles etc. at surface	:	350,000
Total	:	6,750,000

b) Operating cost (Cash cost at mine site)

		(US$/year)
Personnel cost	:	530,600
Consumable materials	:	1,073,600
Electric power	:	24,000
Others	:	500,000
Total	:	2,128,200

Coal production: 200,000t/ year → Unit cost: 10.6 US$/t

2) Underground mine

a) Capital cost (Initial)

		(US$/year)
Surface facilities and equipment	:	3,048,000
Safety equipment	:	982,000
Underground transportation	:	2,300,000
Road development	:	1,284,000
Longwall mining	:	1,758,000
Others	:	450,000
Total	:	9,822,000

In the above amount, the costs of some facilities and vehicles at surface, which are used in open pit mines in common, are not included.

b) Operating cost (in 5th year)

		(US$/year)
Personnel cost	:	1,535,000
Consumable - road development/maintenance	:	526,000
ditto - longwall mining	:	1,230,000
Electric power	:	343,000
Others	:	300,000
Total	:	3,934,000

Coal production/year : 114,181t → Unit cost : 34.5 US$/t

(5) Surface environment

The surface of the mining plan area is mainly utilized for corn field with sparse paddy field near the streams. It seems that mining activities in the area will not have an adverse influence on the land. Attention should be given to the following structures on the surface; a school building and an irrigation canal being under construction. Both of them are located outside the open pit area, but the shallowest part of the planned longwall panels is beneath them. Influence of subsidence on these structures, however, can be prevented by keeping adequate mining restriction zones. Ph.3.3-3 is a general view of the mining plan area.

(6) Coal quality

The quality of the product coal from the mining plan area is estimated in the similar way of the Nong Plab Basin. Analytical data of four boreholes are available for this purpose. The data of MLG2/38 are used only for thickness determination, because of inconsistency between the existing logs and sampled sections. Some sampled portions recorded in the analytical results are outside of the coal plies described in the geological logs.

The following are the assumptions and method applied for the estimation of the coal quality.

1) Mining thickness

The thickness of the mining section and its lithological components are determined averaging those of five boreholes as shown below;

Open pit : Full seam thickness

Underground: 2.5 m from the top

	Open pit (m)	Underground (m)
coal	4.72	2.00
carbonaceous mudstone	0.40	0.29
mudstone	0.24	0.26
Total	5.36*	2.55**

* including 10cm of mining loss at top and 5cm of out-of seam dilution (OSD) from both roof and floor.

** including 5cm of OSD from roof.

2) Quality of mined coal

Quality of coal and carbonaceous mudstone in the mining section are estimated as an average of available analytical data. Quality of mudstone is assumed to be of no heating value.

Using the above quality values, the quality of the mining section on a dry basis is calculated as a weighted average by thickness and specific gravity. Raw coal quality on a mined basis is obtained by adding the following assumed moisture content, coal: 30%, carbonaceous mudstone: 25% and mudstone: 20%.

3) Quality of product coal

The quality of final product is estimated on the assumption that 80% of mudstone is to be removed by screening and hand-picking.

The estimated product coal quality of both open pit and underground mines is summarized in Table 3.3-7 and 3.3-8.

4) Possible demand for the product

On account of relatively high heating value as lignite, this coal can be supplied to cement factories. However, being relatively low sulfur content as lignite in Thailand. The power plants will need this coal in order to mitigates pollution caused by combustion of common lignite of high sulphur and low heating value.

Table 3.3-7 Coal Quality of Mae Lamao Proposed U/G Mine

hole No.		sample No.		from	to	thick	as analysed basis SpGr	M	ASH	VM	FC	(FR)	CV	TS	dry basis SpGr	ASH	VM	CV	TS	TSmg/kcal	ASTM class Btu/lb	Class
ML	1 /37	MLC	5	137.25	137.35	0.10	1.336	14.49	3.62	36.77	45.12	1.23	5576	0.53	1.417	4.23	43.00	6521	0.62	0.95	10449	subB
ML	1 /37	MLC	4	136.80	136.90	0.10	1.406	13.41	8.23	34.77	43.59	1.25	5192	2.11	1.500	9.50	40.15	5996	2.44	4.06	10272	subB
ML	1 /37	MLC	7	138.25	138.35	0.10	1.388	10.81	16.46	35.79	36.94	1.03	4925	0.52	1.456	18.45	40.13	5522	0.58	1.06	10788	subA
ML	1 /37	MLC	6	137.75	137.85	0.10	1.448	13.01	25.88	28.35	32.76	1.16	4085	0.46	1.552	29.75	32.59	4696	0.53	1.13	10209	subB
ML	1 /37	MLC	2	136.10	136.20	0.10	1.489	13.17	27.39	28.06	31.38	1.12	3825	1.04	1.608	31.54	32.32	4405	1.20	2.72	9783	subB
ML	1 /37	MLC	3	136.50	136.60	0.10	1.681	9.77	44.36	23.02	22.85	0.99	2791	1.23	1.815	49.16	25.51	3093	1.36	4.41	9652	subB
ML	1 /37	MLC	1	135.70	135.80	0.10	1.719	11.49	47.77	23.29	17.45	0.75	2882	1.28	1.896	53.97	26.31	3256	1.45	4.44	10740	subA
	1 /37	C				2.33	1.457	12.44	20.82	31.19	35.55	1.14	4412	0.98	1.558	23.78	35.62	5039	1.12	2.23	10253	subB
	1 /37	CSH				0.00	1.719	11.49	47.77	23.29	17.45	0.75	2882	1.28	1.896	53.97	26.31	3256	1.45	4.44	10740	subA
	1 /37	MDST				0.22																
ML	7 /37	MLC	39	276.90	277.00	0.10	1.289	14.83	8.45	35.87	40.85	1.14	5290	1.09	1.357	9.92	42.12	6211	1.28	2.06	10487	subB
ML	7 /37	MLC	34	274.65	274.75	0.10	1.300	14.69	9.22	34.42	41.67	1.21	5230	1.01	1.371	10.81	40.35	6131	1.18	1.93	10464	subB
ML	7 /37	MLC	38	276.40	276.50	0.10	1.337	13.22	17.64	33.60	35.54	1.06	4725	0.38	1.409	20.33	38.72	5445	0.44	0.80	10510	subA
ML	7 /37	MLC	35	274.95	275.05	0.10	1.360	13.85	18.47	30.52	37.16	1.22	4567	0.51	1.444	21.44	35.43	5301	0.59	1.12	10273	subB
ML	7 /37	MLC	37	275.90	276.00	0.10	1.368	12.96	22.82	30.27	33.95	1.12	4364	0.39	1.447	26.22	34.78	5014	0.45	0.89	10428	subB
ML	7 /37	MLC	36	275.40	275.50	0.10	1.444	11.13	36.38	27.28	25.21	0.92	3551	0.45	1.529	40.94	30.70	3996	0.51	1.27	10534	subA
	7 /37	C				2.40	1.349	13.45	18.70	32.04	35.81	1.12	4630	0.64	1.426	21.61	37.01	5350	0.74	1.39	10450	subB
	7 /37	CSH				0.10																
	7 /37	MDST				0.05																
ML	23 /37	MLC	153	68.00	68.05	0.05	1.304	23.75	7.50	33.41	35.34	1.06	4791	2.35	1.440	9.84	43.82	6283	3.08	4.91	9388	subC
ML	23 /37	MLC	157	70.90	70.95	0.05	1.304	21.98	10.01	31.83	36.18	1.14	4669	3.09	1.426	12.83	40.80	5984	3.96	6.62	9429	subC
ML	23 /37	MLC	154	68.45	68.50	0.05	1.313	19.14	12.03	33.13	35.70	1.08	4722	2.77	1.418	14.88	40.97	5840	3.43	5.87	9781	subB
ML	23 /37	MLC	156	69.65	69.70	0.05	1.356	20.75	11.97	32.16	35.12	1.09	4377	3.68	1.495	15.10	40.58	5523	4.64	8.41	9047	subC
ML	23 /37	MLC	155	69.15	69.20	0.05	1.314	24.35	12.02	30.41	33.22	1.09	4437	1.88	1.462	15.89	40.20	5865	2.49	4.24	9179	subC
ML	23 /37	MLC	152	67.65	67.70	0.05	1.736	13.50	59.51	16.21	10.78	0.67	1642	1.16	1.961	68.80	18.74	1898	1.34	7.06	8257	ligA
		C				1.73	1.318	21.99	10.69	32.20	35.12	1.09	4602	2.75	1.448	13.71	41.27	5899	3.52	5.97	9369	subC
		CSH				0.77	1.736	13.50	59.51	16.21	10.78	0.67	1642	1.16	1.961	68.80	18.74	1898	1.34	7.06	8257	ligA
		MDST				0.05																
ML	8 /38	MLC	24	241.00	241.05	0.05	1.301	13.82	5.23	36.95	44.00	1.19	5516	0.75	1.367	6.07	42.88	6401	0.87	1.36	10629	subA
ML	8 /38	MLC	25	241.50	241.55	0.05	1.337	15.21	9.01	35.23	40.55	1.15	4989	0.55	1.423	10.63	41.55	5884	0.65	1.10	9951	subB
ML	8 /38	MLC	26	242.00	242.05	0.05	1.459	11.68	25.09	30.31	32.92	1.09	4182	0.63	1.563	28.41	34.32	4735	0.71	1.51	10331	subB
	8 /38	C				2.37	1.365	13.57	12.99	34.21	39.23	1.15	4903	0.64	1.448	15.03	39.58	5673	0.74	1.31	10272	subB
	8 /38	CSH				0.00																
	8 /38	MDST				0.18																
MLG	2 /38	C				1.19																
	2 /38	CSH				0.57																
	2 /38	MDST				0.79																

		thick	as mined basis SpGr	M	ASH	VM	FC	(FR)	CV	TS	dry basis SpGr	ASH	VM	CV	TS	TSmg/kcal	ASTM class Btu/lb	Class
Mae Lamao U/G	COAL	2.00	1.288	30.00	12.97	26.86	30.17	1.12	3843	1.07	1.470	18.53	38.37	5490	1.53	2.79	8037	ligA
	CSH	0.29	1.565	25.00	46.04	16.89	12.07	0.71	1933	1.05	1.929	61.38	22.53	2577	1.39	5.41	6895	ligA
	MDST	0.26	1.818	20.00	72.36	7.64	0.00	0.00	0	0.80	2.285	90.45	9.55	0	1.00			
	ROM including OSD	2.55	1.373	28.02	25.18	23.00	23.80	1.03	3083	1.03	1.607	34.98	31.96	4282	1.43	3.35	7610	ligA
	PRODUCT		1.334	28.98	19.52	24.85	26.65	1.07	3452	1.06	1.545	27.49	34.98	4861	1.49	3.07	7865	ligA

Table 3.3-8 Coal Quality of Mae Lamao Proposed O/P Mine 1/2

hole No.		sample No.					as analysed basis								dry basis						ASTM class	
				from	to	thick	SoGr	M	ASH	VM	FC	(FR)	CV	TS	SoGr	ASH	VM	CV	TS	TSmg/kcal	Btu/lb	Class
ML	1 /37	MLC	5	137.25	137.35	0.10	1.336	14.49	3.62	36.77	45.12	1.23	5576	0.53	1.417	4.23	43.00	6521	0.62	0.95	10449	subB
ML	1 /37	MLC	10	139.75	139.85	0.10	1.409	13.62	7.48	35.58	43.32	1.22	5127	1.41	1.506	8.66	41.19	5935	1.63	2.75	10048	subB
ML	1 /37	MLC	4	136.80	136.90	0.10	1.406	13.41	8.23	34.77	43.59	1.25	5192	2.11	1.500	9.50	40.15	5996	2.44	4.06	10272	subB
ML	1 /37	MLC	7	138.25	138.35	0.10	1.388	10.81	16.46	35.79	36.94	1.03	4925	0.52	1.456	18.45	40.13	5522	0.58	1.06	10788	subA
ML	1 /37	MLC	9	139.25	139.35	0.10	1.477	12.65	18.68	32.30	36.37	1.13	4444	0.53	1.587	21.39	36.98	5088	0.61	1.19	10024	subB
ML	1 /37	MLC	12	140.75	140.85	0.10	1.557	10.53	19.48	35.57	34.42	0.97	4058	6.22	1.666	21.77	39.76	4536	6.95	15.33	9258	subC
ML	1 /37	MLC	11	140.25	140.35	0.10	1.473	9.30	24.10	35.33	31.27	0.88	4384	2.03	1.548	26.57	38.95	4834	2.24	4.63	10692	subA
ML	1 /37	MLC	6	137.75	137.85	0.10	1.448	13.01	25.88	28.35	32.76	1.16	4085	0.46	1.552	29.75	32.59	4656	0.53	1.13	10209	subB
ML	1 /37	MLC	2	136.10	136.20	0.10	1.489	13.17	27.39	28.06	31.38	1.12	3825	1.04	1.608	31.54	32.32	4405	1.20	2.72	9783	subB
ML	1 /37	MLC	3	136.50	136.60	0.10	1.681	9.77	44.36	23.02	22.85	0.99	2791	1.23	1.815	49.16	25.51	3093	1.36	4.41	9652	subB
ML	1 /37	MLC	8	138.75	138.85	0.10	1.759	6.87	47.29	26.61	19.23	0.72	2737	3.48	1.863	50.78	28.57	2939	3.74	12.71	10109	subB
ML	1 /37	MLC	1	135.70	135.80	0.10	1.719	11.49	47.77	23.29	17.45	0.75	2882	1.28	1.896	53.97	26.31	3256	1.45	4.44	10740	subA
		COAL				4.21	1.465	12.08	19.43	32.58	35.91	1.10	4451	1.60	1.566	22.10	37.06	5063	1.82	3.59	10152	subB
		CSH				0.00	1.739	9.18	47.57	24.92	18.33	0.74	2813	2.35	1.880	52.37	27.44	3098	2.59	8.37	10449	subB
		MDST				0.30																
ML	7 /37	MLC	39	276.90	277.00	0.10	1.289	14.83	8.45	35.87	40.85	1.14	5290	1.09	1.357	9.92	42.12	6211	1.28	2.06	10487	subB
ML	7 /37	MLC	24	274.65	274.75	0.10	1.300	14.69	9.22	34.42	41.67	1.21	5230	1.01	1.371	10.81	40.35	6131	1.18	1.93	10464	subB
ML	7 /37	MLC	40	277.40	277.50	0.10	1.292	13.67	10.57	36.11	39.65	1.10	5280	0.72	1.355	12.24	41.83	6116	0.83	1.36	10736	subA
ML	7 /37	MLC	45	279.95	280.05	0.10	1.423	13.85	14.06	34.03	38.06	1.12	4983	1.04	1.527	16.32	39.50	5784	1.21	2.09	10585	subA
ML	7 /37	MLC	46	280.45	280.55	0.10	1.425	15.42	15.94	32.11	36.53	1.14	4559	0.42	1.545	18.85	37.96	5390	0.50	0.92	9915	subB
ML	7 /37	MLC	38	276.40	276.50	0.10	1.337	13.22	17.64	33.60	35.54	1.06	4725	0.38	1.409	20.33	38.72	5445	0.44	0.80	10510	subA
ML	7 /37	MLC	35	274.95	275.05	0.10	1.360	13.85	18.47	30.52	37.16	1.22	4567	0.51	1.444	21.44	35.43	5301	0.59	1.12	10273	subB
ML	7 /37	MLC	37	275.90	276.00	0.10	1.368	12.96	22.82	30.27	33.95	1.12	4364	0.39	1.447	26.22	34.78	5014	0.45	0.89	10428	subB
ML	7 /37	MLC	44	279.40	279.50	0.10	1.524	13.31	24.07	29.75	32.87	1.10	4170	0.29	1.657	27.77	34.32	4810	0.33	0.70	10145	subB
ML	7 /37	MLC	43	278.90	279.00	0.10	1.537	13.60	27.23	27.24	31.93	1.17	3821	0.42	1.679	31.52	31.53	4422	0.49	1.10	9745	subB
ML	7 /37	MLC	42	278.40	278.50	0.10	1.583	12.57	31.93	26.07	29.43	1.13	3665	0.34	1.728	36.52	29.82	4192	0.39	0.93	10072	subB
ML	7 /37	MLC	41	277.90	278.00	0.10	1.565	11.97	32.18	25.88	29.97	1.16	3654	0.32	1.695	36.56	29.40	4151	0.36	0.88	10083	subB
ML	7 /37	MLC	36	275.40	275.50	0.10	1.444	11.13	36.38	27.28	25.21	0.92	3551	0.45	1.529	40.94	30.70	3996	0.51	1.27	10534	subA
ML	7 /37	MLC	50	282.60	282.70	0.10	1.741	8.95	47.28	23.22	20.55	0.89	2750	0.79	1.878	51.93	25.50	3020	0.87	2.87	10124	subB
ML	7 /37	MLC	48	281.45	281.55	0.10	1.773	9.14	48.80	23.19	18.87	0.81	2704	1.65	1.922	53.71	25.52	2976	1.82	6.10	10314	subB
ML	7 /37	MLC	47	280.95	281.05	0.10	1.583	8.63	50.38	20.84	20.15	0.97	2529	0.38	1.675	55.14	22.81	2768	0.42	1.50	9989	subB
ML	7 /37	MLC	49	281.95	282.05	0.10	1.862	7.92	55.47	21.13	15.48	0.73	2163	1.59	2.011	60.24	22.95	2349	1.73	7.35	9725	subB
		COAL				6.88	1.420	13.467	20.596	31.048	34.889	1.124	4457	0.570	1.519	23.801	35.880	5151	0.658	1.278	10323	subB
		CSH				0.20	1.740	8.660	50.469	22.100	18.771	0.849	2538	1.102	1.872	55.254	24.195	2778	1.207	4.343	10054	subB
		MDST				0.00																
ML	23 /37	MLC	153	68.00	68.05	0.05	1.304	23.75	7.50	33.41	35.34	1.06	4791	2.35	1.440	9.84	43.82	6283	3.08	4.91	9384	subC
ML	23 /37	MLC	157	70.90	70.95	0.05	1.304	21.98	10.01	31.83	36.18	1.14	4669	3.09	1.426	12.83	40.80	5984	3.96	6.62	9429	subC
ML	23 /37	MLC	154	68.45	68.50	0.05	1.313	19.14	12.03	33.13	35.70	1.08	4722	2.77	1.418	14.88	40.97	5840	3.43	5.87	9781	subB
ML	23 /37	MLC	156	69.65	69.70	0.05	1.356	20.75	11.97	32.16	35.12	1.09	4377	3.68	1.495	15.10	40.58	5523	4.64	8.41	9047	subC
ML	23 /37	MLC	155	69.15	69.20	0.05	1.314	24.35	12.02	30.41	33.22	1.09	4437	1.88	1.462	15.89	40.20	5865	2.49	4.24	9179	subC
ML	23 /37	MLC	158	70.28	70.35	0.07	1.431	18.27	26.03	27.28	28.42	1.04	3694	4.02	1.584	31.85	33.38	4520	4.92	10.88	9254	subC
ML	23 /37	MLC	152	67.65	67.70	0.05	1.736	13.50	59.51	16.21	10.78	0.67	1642	1.16	1.961	68.80	18.74	1898	1.34	7.06	8257	ligA
		COAL				1.68	1.336	21.37	13.15	31.42	34.05	1.08	4458	2.95	1.471	16.73	39.96	5669	3.75	6.62	9357	subC
		CSH				0.64	1.736	13.50	59.51	16.21	10.78	0.67	1642	1.16	1.961	68.80	18.74	1898	1.34	7.06	8257	ligA
		MDST				0.00																

Coal Quality of Mae Lamao Proposed O/P Mine 2/2

hole No.		sample No.		from	to	thick	as analysed basis SpGr	M	ASH	VM	FC	(FR)	CV	TS	dry basis SpGr	ASH	VM	CV	TS	TSmj/kcal	ASTM class Btu/lb	Class
ML	8 /38	MLC	24	241.00	241.05	0.05	1.301	13.82	5.23	36.95	44.00	1.19	5516	0.75	1.367	6.07	42.88	6401	0.87	1.36	10529	subA
ML	8 /38	MLC	25	241.50	241.55	0.05	1.337	15.21	9.01	35.23	40.55	1.15	4989	0.55	1.423	10.63	41.55	5884	0.65	1.10	9951	subB
ML	8 /38	MLC	27	242.50	242.55	0.05	1.342	14.48	12.08	33.95	39.49	1.16	5104	0.51	1.424	14.13	39.70	5968	0.60	1.00	10570	subA
ML	8 /38	MLC	30	244.00	244.05	0.05	1.353	11.71	21.75	31.31	35.23	1.13	4386	0.72	1.419	24.63	35.46	4968	0.82	1.64	10325	subB
ML	8 /38	MLC	32	245.00	245.05	0.05	1.496	11.48	23.57	29.97	34.98	1.17	4181	1.12	1.599	26.63	33.86	4723	1.27	2.68	10104	subB
ML	8 /38	MLC	26	242.00	242.05	0.05	1.459	11.68	25.09	30.31	32.92	1.09	4182	0.63	1.553	28.41	34.32	4735	0.71	1.51	10331	subB
ML	8 /38	MLC	31	244.50	244.55	0.05	1.532	10.15	28.68	29.73	31.44	1.06	3771	2.74	1.630	31.92	33.09	4197	3.05	7.27	9850	subB
ML	8 /38	MLC	35	246.50	246.55	0.05	1.496	10.81	29.61	28.52	31.06	1.09	3861	0.60	1.592	33.20	31.98	4329	0.67	1.55	10223	subB
ML	8 /38	MLC	34	246.00	246.05	0.05	1.577	11.15	31.83	26.95	30.07	1.12	3673	0.50	1.700	35.82	30.33	4134	0.56	1.36	10079	subB
ML	8 /38	MLC	33	245.50	245.55	0.05	1.527	10.28	33.91	26.29	29.52	1.12	3505	0.42	1.625	37.80	29.30	3907	0.47	1.20	9958	subB
ML	8 /38	MLC	36	246.95	247.00	0.05	1.680	9.56	38.90	27.02	24.52	0.91	3343	1.98	1.810	43.01	29.88	3696	2.19	5.92	10402	subB
ML	8 /38	MLC	29	243.50	243.55	0.05	1.585	9.09	41.43	23.67	25.81	1.09	3082	0.44	1.683	45.57	26.04	3390	0.48	1.43	10044	subB
ML	8 /38	MLC	28	243.00	243.05	0.05	1.617	8.94	41.66	25.99	23.41	0.90	3157	0.73	1.721	45.75	28.54	3467	0.80	2.31	10340	subB
		COAL				6.03	1.482	11.41	26.14	29.77	32.68	1.10	4075	0.90	1.581	29.50	33.61	4600	1.01	2.20	10228	subB
		CSH				0.16																
		MDST				0.78																
MLG	2 /38	COAL				4.82																
		CSH				0.99																
		MDST				0.10																

		thick	as mined basis SpGr	M	ASH	VM	FC	(FR)	CV	TS	dry basis SpGr	ASH	VM	CV	TS	TSmj/kcal	ASTM class Btu/lb	Class
Mae Lamao O/C	COAL	4.72	1.322	30.00	16.12	25.64	28.24	1.10	3584	1.27	1.534	23.04	36.63	5121	1.81	3.53	7802	ligA
	CSH	0.40	1.553	25.00	44.11	17.59	13.30	0.76	1944	1.28	1.904	58.81	23.46	2591	1.71	6.61	6648	ligA
	MDST	0.24	1.818	20.00	72.36	7.64	0.00	0.00	0	0.80	2.285	90.45	9.55	0	1.00			
	ROM	5.36	1.361	28.99	21.80	23.90	25.31	1.06	3235	1.24	1.596	30.71	33.65	4555	1.75	3.84	7602	ligA
	PRODUCT		1.344	29.43	19.31	24.70	26.56	1.08	3394	1.26	1.570	27.36	35.00	4810	1.79	3.72	7707	ligA

4 Geological Database

4.1 The Coal Database in the Master Plan for Coal Resources Management

As mentioned in the chapter 2, DMR enacted The Master Plan for Coal Resources Management of Thailand (dated April, 1996) in September, 1996. The geological database is mentioned and called as "coal database" in the master plan. The master plan was made almost the same time when the Study was executed. The description about the coal database in the plan is introduced to the geological database of the Study, because it clearly shows the concept and needs of the geological database for DMR. Therefore, the main part of the description of the coal database in the master plan are shown herein after.

<u>Coal Database</u>

The data able to be handled by general software are the data from compilation & interpretation of geological information that are concluded as numeric data of both quantity and quality. Others are data generated from following and controlling on execution plan of coal exploration and assessment as well as administrative works. These data can be classified as follows;

(1) Data concerning exploration work control

This is the database system for keeping record of execution plan, target, and exploration activities. It also includes some main activities such as monthly report of each individual survey team. This database management will facilitate the evaluation of working.

(2) Data concerning drilling information

This include bore hole location, name of boreholes, commenced date, depth of hole, thickness of coal seams in each hole. This database is for reporting details for each individual hole.

(3) Data concerning coal potential assessment

This include information on coal analyses, number of analyzed samples, analytical results, detail about samples, sending-receiving data etc. The database will facilitate in data compilation and presentation as well as use in conjunction with other data for coal potential assessment.

In the system, each individual record in the database will include data that are related together. Data from different "Tables" should be managed as they are in the same group. This could be done by specific data in the field that are related together. From their relation among the "Table", it is required to select the component or "Query" to select only the data needed. For example, in preparation of monthly report of the survey team, the report should be combined from the selected data from several CEP-firms in which some of the data can be disregarded.

The database management system should have functions or tools in order to improve and update the data all the times. It should also have ability to display data on screen by receiving data from "Query". For examples, drilling activity will have depth increasing until through the bottom of the hole. "Form" will be a tool to use as data correction and will be served as linking between data base and "Query". In the design of "Form", it is not only a correction of data but also represents the preliminary report as well as screen handling in data input into the computer. In general, database should have function called "Report" which is the tool for data presentation in the form of hard copy. For example, "Form" will be the tool to define the computer format of the monthly report, while "Report" will be tool to produce the printed document as data presentation.

From the above information, once the database is set up systematically, the report preparation or data search will be able to use "Macro" which will be the compilation of various commands and various working stages to combine as one representative command. Then, when pressing the key or using one single command, the software will be able to run through various stages which are specified by "Macro". For example, in the preparation of annual drilling results, "Macro" can be replaced the select of data by "Query", presenting the data on the screen by "Form", and then, printing as document by "Report".

Currently, the general database software is produced and applied as basic software in genera; offices. The software have been designed for friendly use and uncomplicated and also could be used as network. Mostly, the working system of the database tend to develop in order to working with WINDOWS. General working formats for recent database soft ware are as follows;

Table	for data input
Query	for view of the selected component of the data
Forms	for data compilation, calculation, and data grouping
Macro	for compilation of commands as function for working and ability to work with writing program

The popular software are as follows;

- dBASE 5.0 for Windows
- Microsoft Access 2.0
- Paradox 5.0 for Windows
- Approach Release 3.0 for Windows
- FoxPro for Windows
- FoxBase
- Oracle
- Clipper

4.2 The Geological database of the Study

The geological database of the Study are designed to process all of the functions which are mentioned in the Master Plan and also geophysical logs are designed.

4.2.1 Basic concept

The database are designed on the basic principles as follows;

1) Reliable and available application software is selected for easy operation, easy data retrieval and analysis.

The geological data base is designed under the Approach (Lotus Smart Suite '97), which is one of the popular application database software as mentioned in the Master Plan. Operation of the database, such as edit data, is accomplished easily by defining data combination of lithological codes.

2) Application of a lithological coding method for simplification.

The lithologic logs contain so large variety of descriptions and classifications in general, therefore a lithological coding method is necessary for simplification. The lithological coding method was agreed between DMR and the Study Team, and its detail and lithological graphic patterns are shown in Table 4.2-1 and Fig.4.2-1.

3) The processing data in the database

The data which are processed and stored in the database are as follows;

Geological data : Location, Depth, Lithological code

Coal quality data : Moisture, Ash, Volatile Matter, Heating Value, Sulfur, Specific Gravity.

The data which are processed, but not stored in the database at present are as follows;

Geophysical logging data : Resistivity log, Spontaneous potential log, Density log, Natural gamma log, Neutron log

4) Outputs

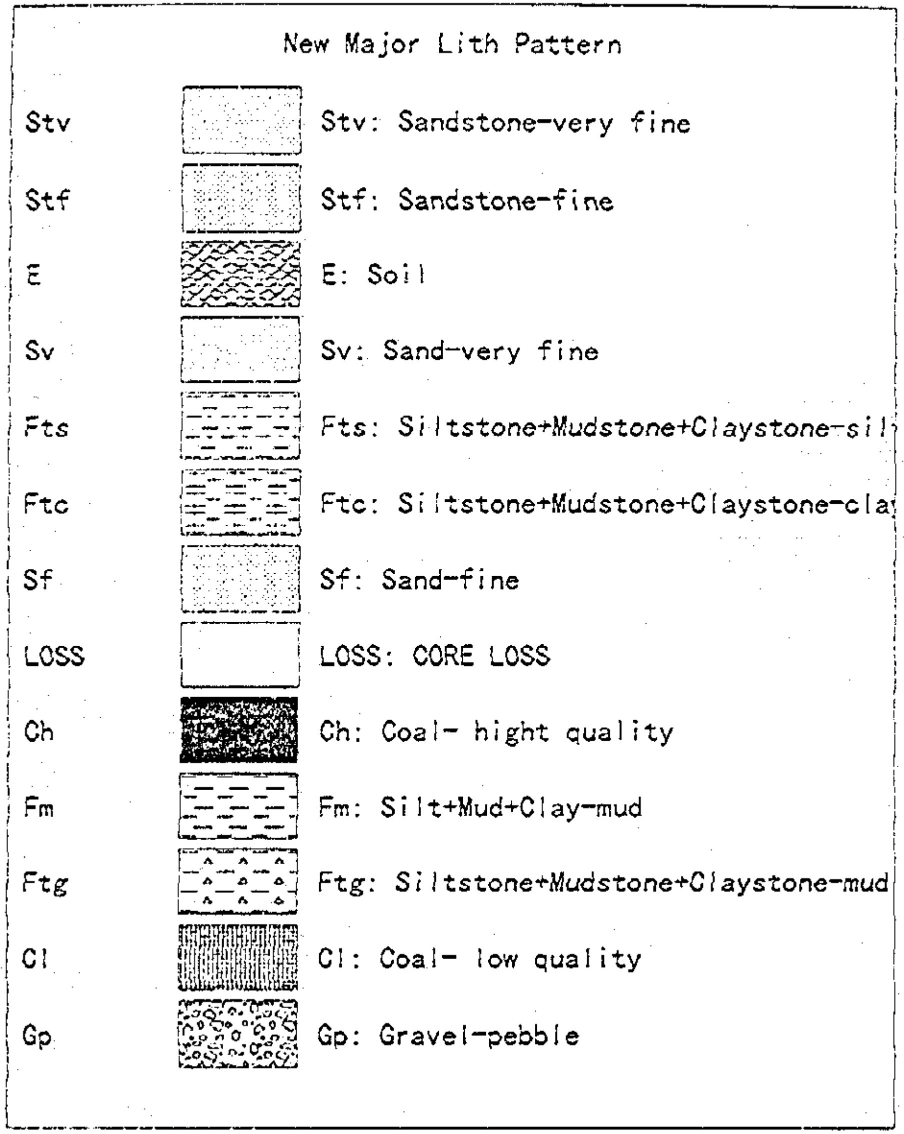
The outputs of the database without ordinary response on the screen are Reports, Lithological log. When the geophysical logging data is transferred, output of the geophysical log which include lithological pattern and depth data is available.

Table 4.2-1 Lithofacies Codes

Grain size	Major		Detail	
	G:	unconsolidated gravel	b:	boulder
	Cg:	conglomerate	c:	cobble
			p:	pebble
	S:	sand (unconsolidated)	g:	granule
	St:	sand stone (consolidated)	c:	coarse
			m:	medium
	F:	silt+mud+clay (unconsolidated)	f:	fine
	Ft:	silt+mud+clay (consolidated)	vf:	very fine
			s:	silt
	C:	coal	m:	mud
			c:	clay
	Cb:	carbonaceous	g:	granule+mud
			h:	high quality
	E:	soil	l:	low quality

Grain	Sphericity		Sorting	
	r:	rounded	w:	well sorted
	sr:	subrounded	p:	poorly sorted
	sa:	subangular		
	a:	angular		
	p:	platy		

Sedimentary Structure	<u>Bedding</u>	
	l:	alternation by lamination
	b:	alternation by banding
	<u>Lamination</u>	
	t:	trough
	p:	planar, steep
	l:	planar, low
	h:	horizontal
	<u>Base of a unit</u>	
	s:	scoring
	g:	gradual change
Remarks	m:	Molluscan fossil
	b:	Bioturbation
	p:	Plant fragments
	cm:	Coaly matter
	v:	Tuff
	q:	Quartzose
	n:	Calcareous or ferruginous nodule
	sl:	Slumping



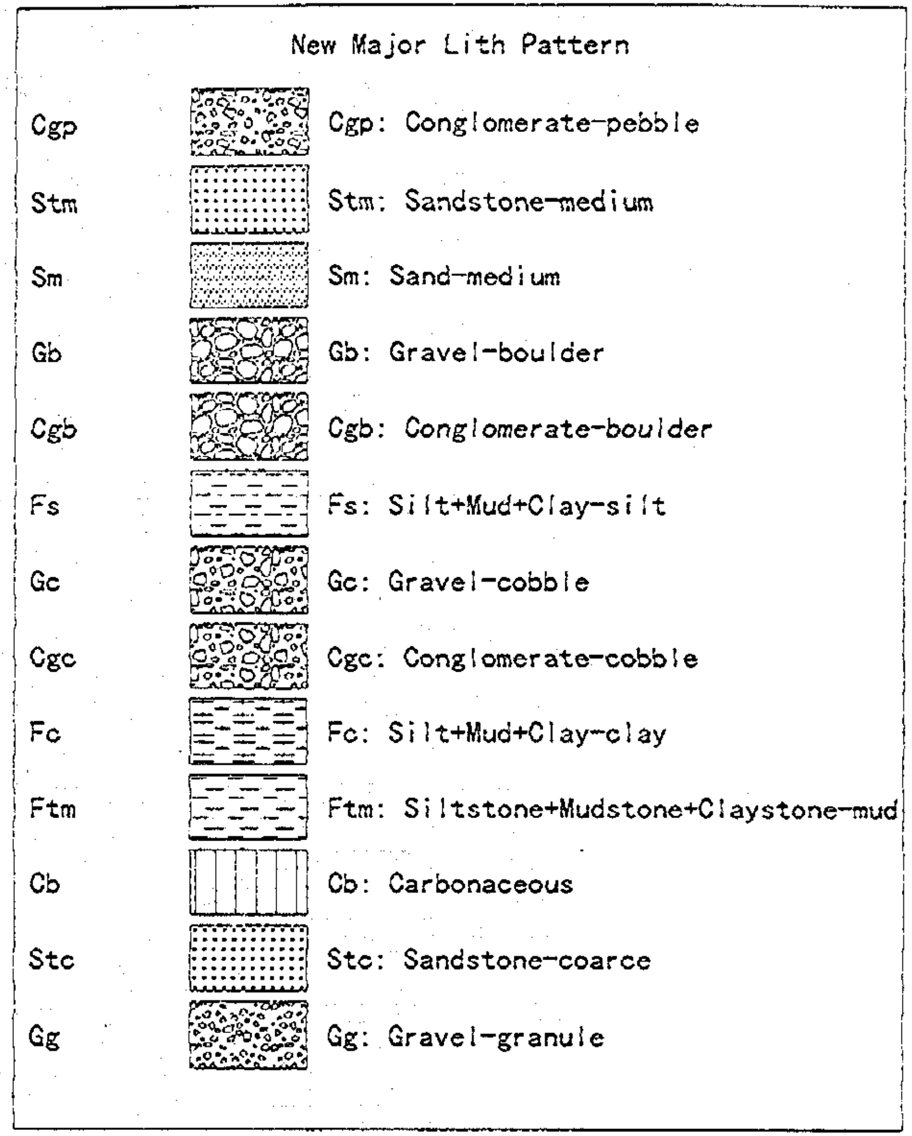


Fig. 4.2-1 Lithological graphic patterns

4.2.2 Data combination (Structure of data)

An example of data combination of lithological code is shown in Fig.4.2-2. Whole lithological code names and the structure of data combination are shown in Fig.4.2-3.

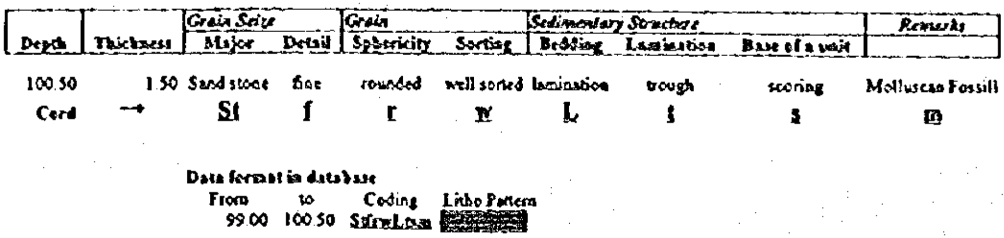


Fig. 4.2-2 Example of data combination

4.2.3 Hardware component

- Computer System

  IBM PC model: 657637C

  - CPU INTEL PENTIUM 75 MHz.
  - 8 MB RAM, 1GB SCSI-2 HDD,SCSI Controller
  - 256 KB Cache, PCI Local BUS 64-bit 1MB/2MB
  - 3.5"1.44 MB FDD, IBM Mouse, PCI/ISA Bus
  - SONY 17" CPD1730 Color Monitor
  - 8 MB RAM Expansion (Total 16 MB)
  - Windows 95

- Plotter

  HP Designjet 600 Plotter (A0 Size)

- Printer

  EPSON Printer Stylus ProXL

The capacity of the database depends on the capacity of the hard disk of the computer system. The computer system of the Study has 1 GB hard disk, it is enough capacity to store the lithological code data of the Study and the study of DMR for the time being. In general, a geophysical log needs capacity of memory rather than lithological data. In addition, a borehole has several geophysical logs usually. Therefore, the geophysical logging data are only processed not stored at present in the database. Capacity of a hard disk increase and it's price decrease day by day, and DMR has created their computer local area network (LAN). It means that purchase of additional hard disk is easy and use of idle hard disks or a part of disks through the LAN is available to meet needs of data storage capacity.

4.2.4 Data flow

The flow chart of the database is shown in Fig. 4.2-4.

4.2.5 Data entry

The data entry screen is shown in Fig. 4.2-5. On this screen, depth of each stratum in a form of "From" and "To", and major cord name are input. "Major" can be defined by selecting a grain size in the drop down menu, and then the screen is changed to the next screen depending on Major selection. "Thickness" can be calculated from "From" and "To" data automatically. The data entry screen of the gravel, a major selection, is shown in Fig. 4.2-5 and succeeding Fig. 4.2-6. Each code can be selected by clicking a mouse on the circle button. Selected data are stored into the database file as the combination of codes.

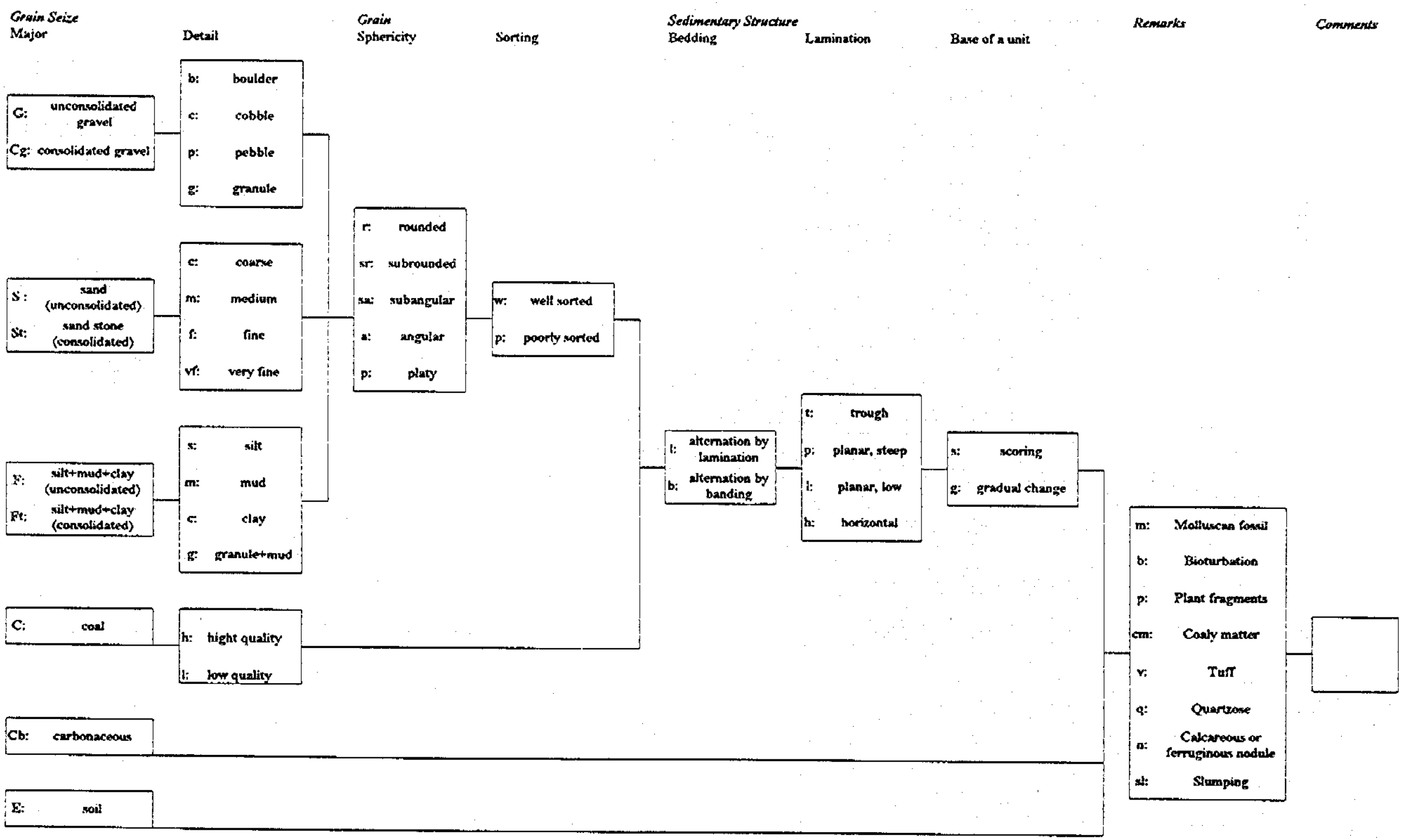
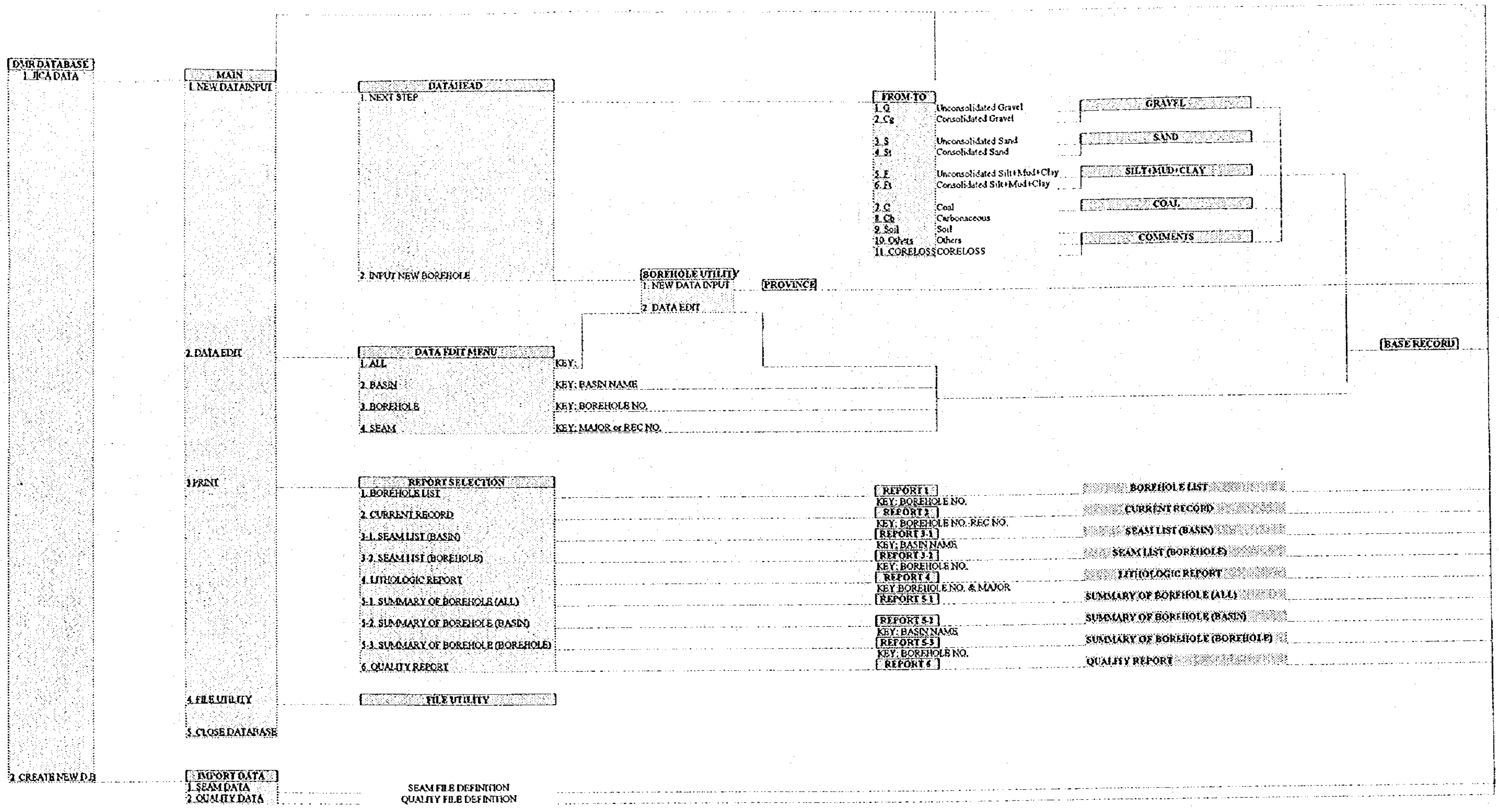


Fig. 4.2-3. Data Coding and Combination



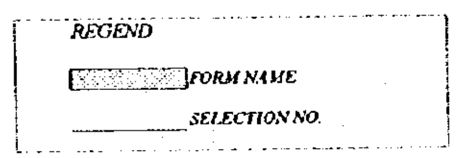


Fig.4.2-4 Flow chart of the database

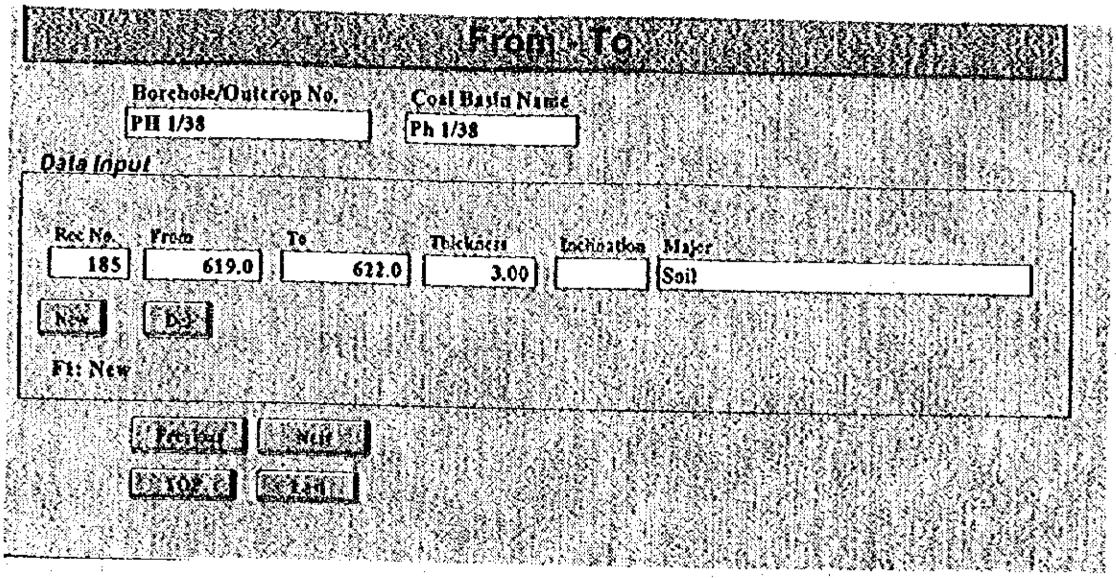


Fig. 4.2-5 Data entry screen (From-To)

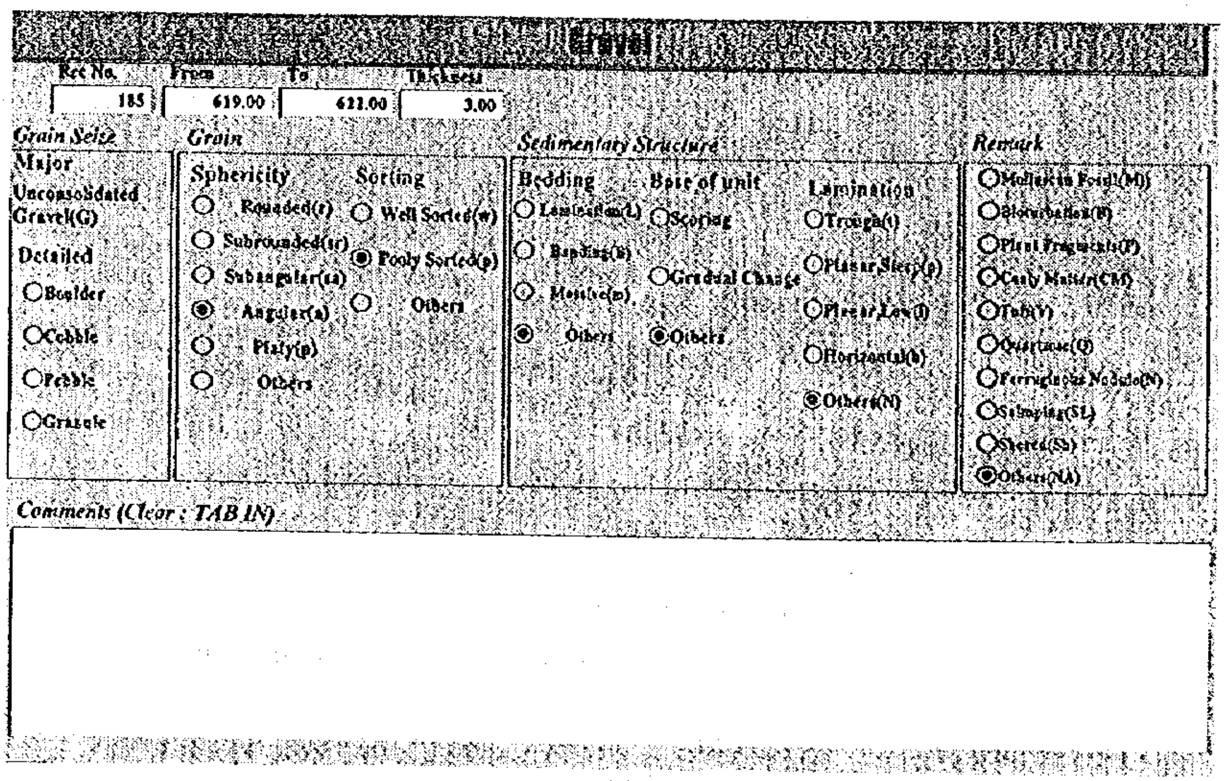


Fig. 4.2-6 Data entry screen (Gravel)

4.2.6 Data analysis and output

(1) Data Analysis and report

The database have two ways to analyze the stored data.

1) It is possible to analyze data by means of using data retrieval function of the application software. However enough experience in operation for the Lotus Approach and computer will be required.

2) The other way of data analysis is to use the regular report formats. In this way, it is easily accomplished by selecting items on the screen. Eight kinds of report formats which are probably used frequently are prepared as follows:

Report 1: Borehole List
/ The list of lithological logs of each borehole.

Report 2: Current Record
/ All information of each stratum.

Report 3-1: Stratum List (Borehole)
/ Stratum list and accumulation of stratum thickness in a borehole.

Report 3-2: Stratum List (Basin)
/ Stratum list and accumulation of the thickness of all borehole in a basin.

Report 4: Lithologic Report
/ Stratum list of each Major code

Report 5-1: Summary (All)
/ Accumulation of stratum thickness and the number of stratum of each code name in all basin.

Report 5-2: Summary (Basin)
/ Accumulation of stratum thickness and number of stratum of boreholes in a basin.

Report 5-3: Summary (Borehole)

/ Accumulation of stratum thickness and number of stratum of a borehole.

For example, Report 4 (Lithologic Report) is shown in Fig.4.2-7. Fig.4.2-8 is a borehole selection menu. Select a borehole name in the menu, then the Lithologic Report appears on the screen shown in Fig.4.2-7. It shows the list of coal beds in a borehole. Total number of these coal beds and accumulated beds thickness are printed at the bottom of the report. Province name and borehole coordinate are on the top. Report 5-2, Summary (Basin) is shown in Fig.4.2-9.

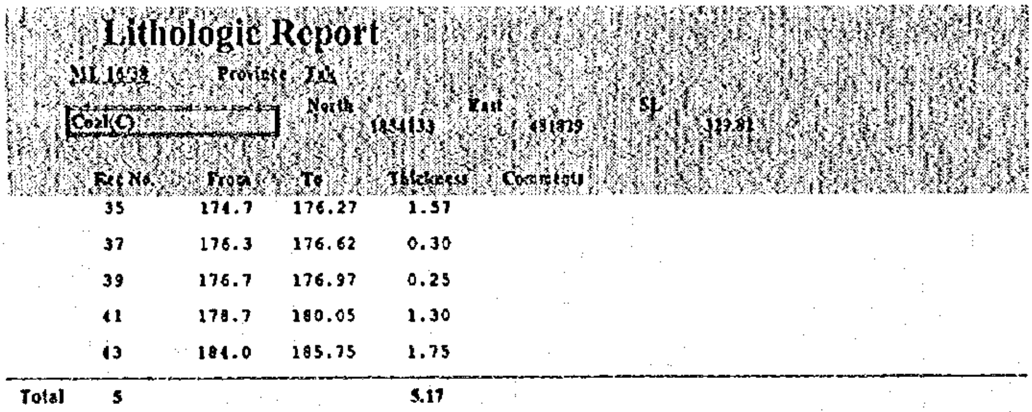
(2) Lithological log.

Output of lithological log which include lithological code, lithological pattern and depth data is available.

(3) Geophysical log

When the geophysical logging data is transferred, output of the geophysical log which include lithological pattern and depth data is available.

Plate 4-1 to 4-6 are the lithological logs and geological logs which are outputs of the geological database system. They are logs of the boreholes of the Study in the Phrae Basin.



Lithologic Report

	Rec No.	From	To	Thickness	Comment
	35	174.7	176.27	1.57	
	37	176.3	176.62	0.30	
	39	176.7	176.97	0.25	
	41	178.7	180.05	1.30	
	43	184.0	185.75	1.75	
Total	5			5.17	

Fig. 4.2-7 Lithologic Report.

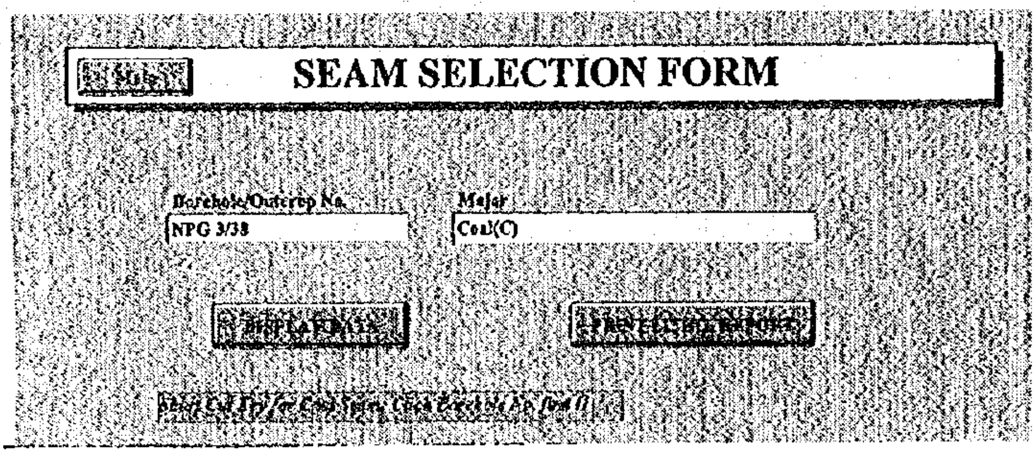


Fig. 4.2-8 Borehole selection menu.

Summary of Basin

	Carbonaceous mud(cb)		Coal(c)		Consolidated Silt-mud-clay(fl)		Core Loss		Soil		Unconsolidated Gravel(g)		Unconsolidated Sand(s)		Unconsolidated Silt-mud-clay(f)		Grand total	
	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness	No of Bed	Total Thickness
Nrg 1/38	14	2.55	9	6.35	1	4.48	30	7.59	1	1.50			8	13.75	33	116.98	73	150.00
Nrg 2/38			4	1.08			9	10.85					9	18.36	36	140.37	58	174.00
Nrg 3/38	9	6.45	4	4.92			4	14.30	1	4.84	1	15.60	3	16.59	36	96.43	55	154.90
Nrg 4/38	4	1.40	4	[illegible]			10	13.70	1	4.85	3	10.50	3	24.48	26	94.74	48	153.40
Nrg 5/38	1	0.49	3	[illegible]			9	6.15	1	1.90			1	19.15	47	84.55	63	113.50
Total	23	13.48	24	19.61	1	4.40	42	56.05	4	4.05	4	26.10	30	95.16	177	532.99	308	745.50

Fig. 4.2-9 Summary (Basin) report.

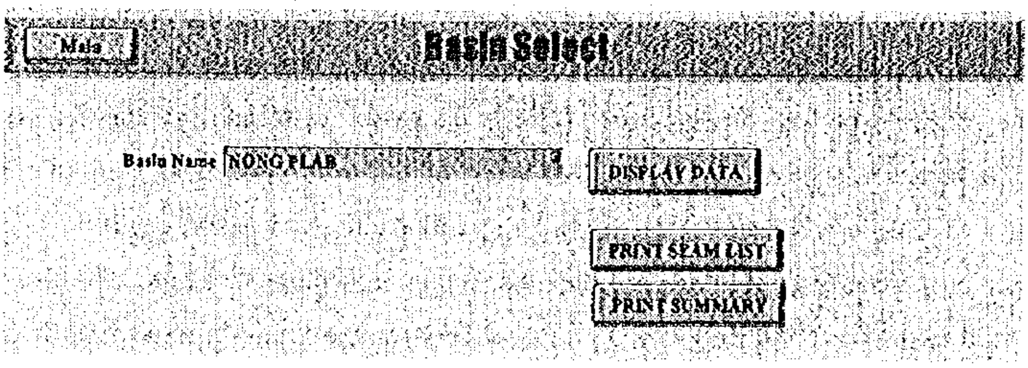


Fig. 4.2-10 Basin selection menu.

5. Technology Transfer

5.1 Planning of technology transfer

DMR is conducting exploration in line with its conventional method intending both identification of the coal basins and estimation of the coal resources. DMR's concept of resources is previously explained in Table 3.1-8. Though the concept of resources and reserves are technical matter, these concept are fundamental for exploration. Therefore these concepts are explained again as follows:

Basic concept	Quantity of coal regardless to technology and economics. For each coal bed & block	A part of the left which is worth assessing mining	A part of the left which is estimated by mining plan under the present economics and technology
The Study	Resources	Reserves	Mineable reserves
USGS	Resources	Reserve base	Reserves
JIS	Theoretic quantity of coal	Theoretically mineable in the left	Estimated quantity by mining plan
DMR(conventional)	Resources regardless each coal bed and block	None	None

As shown in the above table, the conventional DMR's estimation of the resources does not refer the mineable quantity of coal. However it is evaluated realistic in identification of the indigenous energy resources considering the short history of coal mining and a limited number of the experienced geologists. Here is the reason of technology transfer of this Study. In accordance with the scope of work of the Study, technology transfer was planned. Technology transfer of the Study are classified into two aspects, one is to improve conventional technology of DMR, and the other is new technology for them. The plan was described in the Inception Report and discussed between the Study Team and DMR, then agreed by Thai side finaly. The details of the plan were as follows:

(1) Consultation of DMR

Technology transfer shall be conducted after DMR's consultation for the technology transfer plans of each technical field.

(2) Targets

Technology transfer shall aim to transfer systematic and effective technology of exploration, evaluation, geological database, coal quality analysis and mine development necessary for commercial coal production.

(3) Comprehensive analysis and application of the obtained geological and coal quality data;

The obtained geological data shall be analyzed or interpreted with other relevant data and then shall be compiled into geologic maps or sections to estimate the coal resources. Therefore it is necessary to recognize that each datum has significant value and shall be obtained and treated with maximum attention. The geological database is very useful tool in this procedure.

(4) Each technical field

I. Exploration technology (Improvement and New technology)

1) Outcrop survey and route mapping (Improvement)

This technology shall be at first explained to all the members through seminar. Then field work shall be performed by joint work with DMR and the Study team members. This technology will be finally transferred to DMR members so as to be able to perform by themselves.

2) Description of lithology (New technology)

At first, the system of lithofacies code shall be explained through seminar. After obtaining DMR's consent, this system shall be used consistently in order to avoid any personal difference in description.

3) Interpretation of logging and seismic survey data (Improvement)

Procedure of manual interpretation depending on basic theory shall be explained with some suitable examples. If DMR has software for analysis of logging, it will be compared to manual interpretation.

4) Basin analysis technology (New technology)

This technology shall be explained through joint work of data analysis. The proposed lithofacies coding method is planned to obtain data of facies by simplified system. Facies can be deduced to sedimentary environments which influenced the deposition of coal beds, especially variation of coal bed morphology. This technology can be applied to more effective exploration predicting or confirming lateral change of the coal beds.

II Technology for geological database (New technology)

In order to accomplish effective transfer, Japanese expert shall complete each program module of the database firstly in Japan, then he shall explain to the counterpart specialist the details of the program and used software programming know-how.

III Technology for coal quality analysis (Improvement and New technology)

Operation technology of coal quality analysis and test equipment which shall be provided by JICA, and information for coal quality evaluation standard shall be transferred.

IV Technology for underground coal mine development (New technology)

Due to the condition that underground coal mining has not been experienced in Thailand, technology transfer shall cover broad coal mining technology in terms of mine structures, mining plan, mining method, ventilation system, countermeasures for risk, major equipment and investment. In order to accomplish effective transfer, some examples shall be shown in order to explain the most important items to be assessed such as risks and their countermeasures and environmental impact.