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 were studied.

(1) Basic conditions

1) Mining area

A block bounded by E and F faults in the northeastern part is selected.

2) Portal location and mine access

The 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. 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

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

(2) Mining system

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

Dimensions for the two mining methods are as follows;

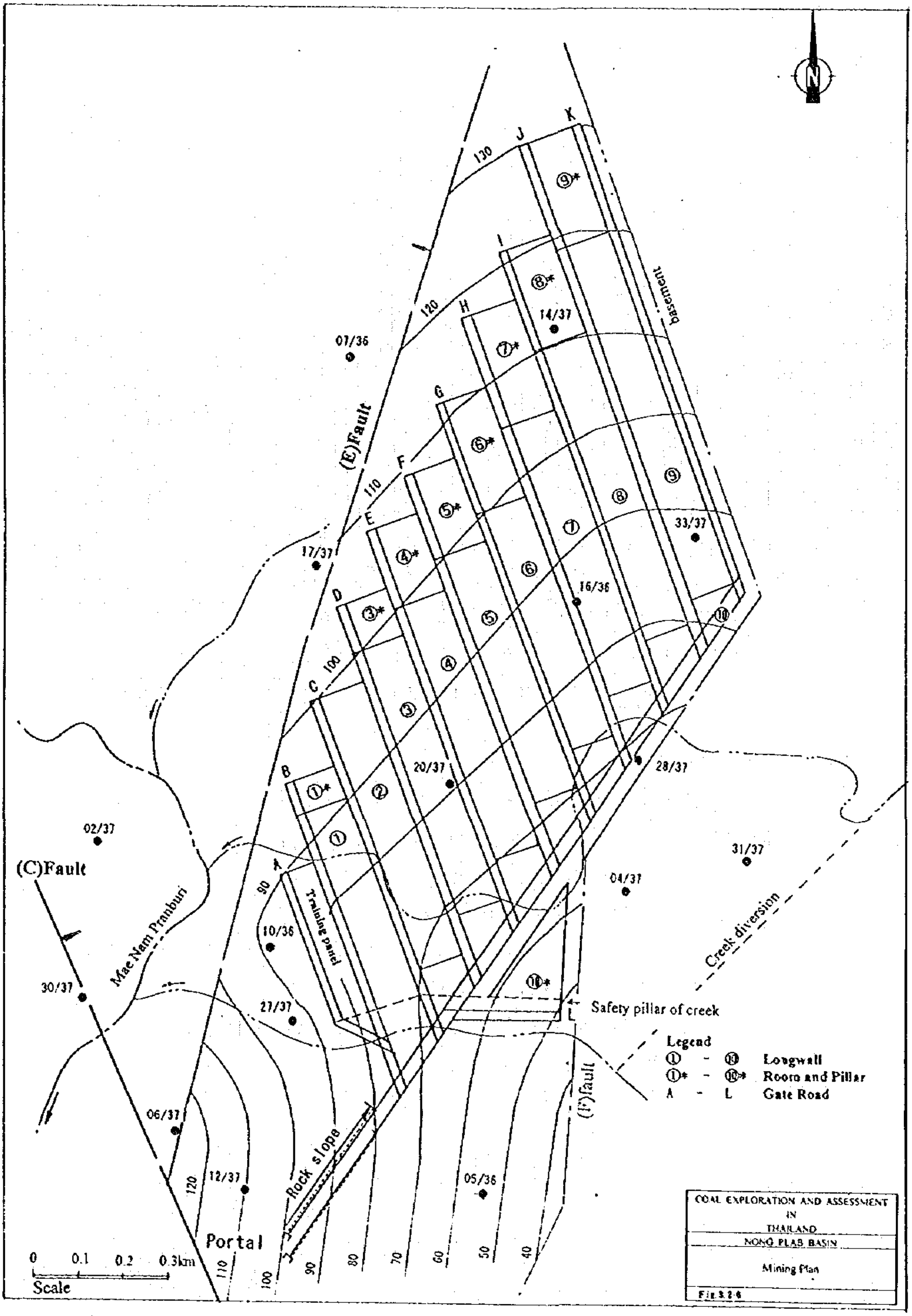
L/W : Panel size - 95 m wide x 500-800 m long

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


(E)Fault
(C)Fault
(F')fault
basement
Mae Nam Pranburi
Creek diversion
Safety pillar of creek
Training panel
Rock slope
Portal
Legend
① - ⑩ Longwall
①* - ⑩* Room and Pillar
A - L Gate Road
0 0.1 0.2 0.3km
Scale
01/36
02/37
04/37
05/36
06/37
10/36
12/37
14/37
16/36
17/37
20/37
27/37
28/37
30/37
31/37
33/37
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
NONG PLAB BASIN
Mining Plan
Fig.3.2-6

(3) Coal production

1) Working system

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

Number of production crews per shifts

Longwall : 1 crew

Roadway and Room & Pillar :

2 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

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	Staffs	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 3.2-3 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	5,700	11,820				5,700		5,700	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
K.P. ①=			7,700																	7,700
③=					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
KAP	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
T. 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. Consequently, the estimated costs summarized below should be regarded as at rough level in accuracy.

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 been found in the area. It is unlikely, therefore, that mining activities have a significant influence on 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.

(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)

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 were changed to carbonaceous mudstone because of their high ash content.

The lower half of the coal bed in NP10/36 is questionable in quality due to its abnormally thick coal. Therefore, this portion was included into mining section as carbonaceous mudstone. The thickness of each lithologic component in mining thickness is determined by 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 were 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 was 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 results of the estimation of product coal quality by way of the above procedures are shown in Table 3.2-4.

Table 3.2-4 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 extends to NW-SE direction covering an area of approximately 90 km^2. 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.

3.3.2 Exploration and geological investigation

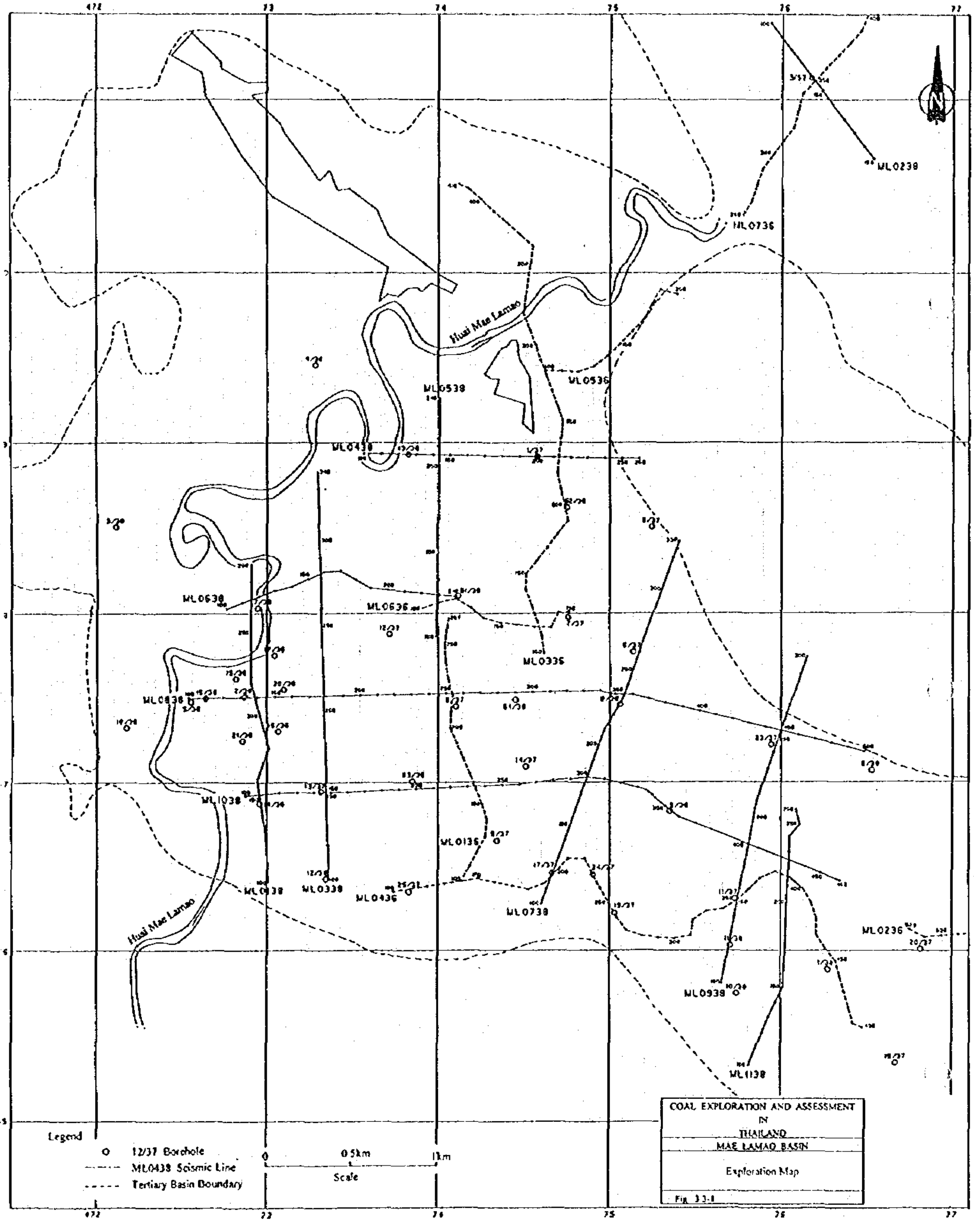
(1) Exploration

Table 3.3-1 Exploration in the Mae Lamao Basin

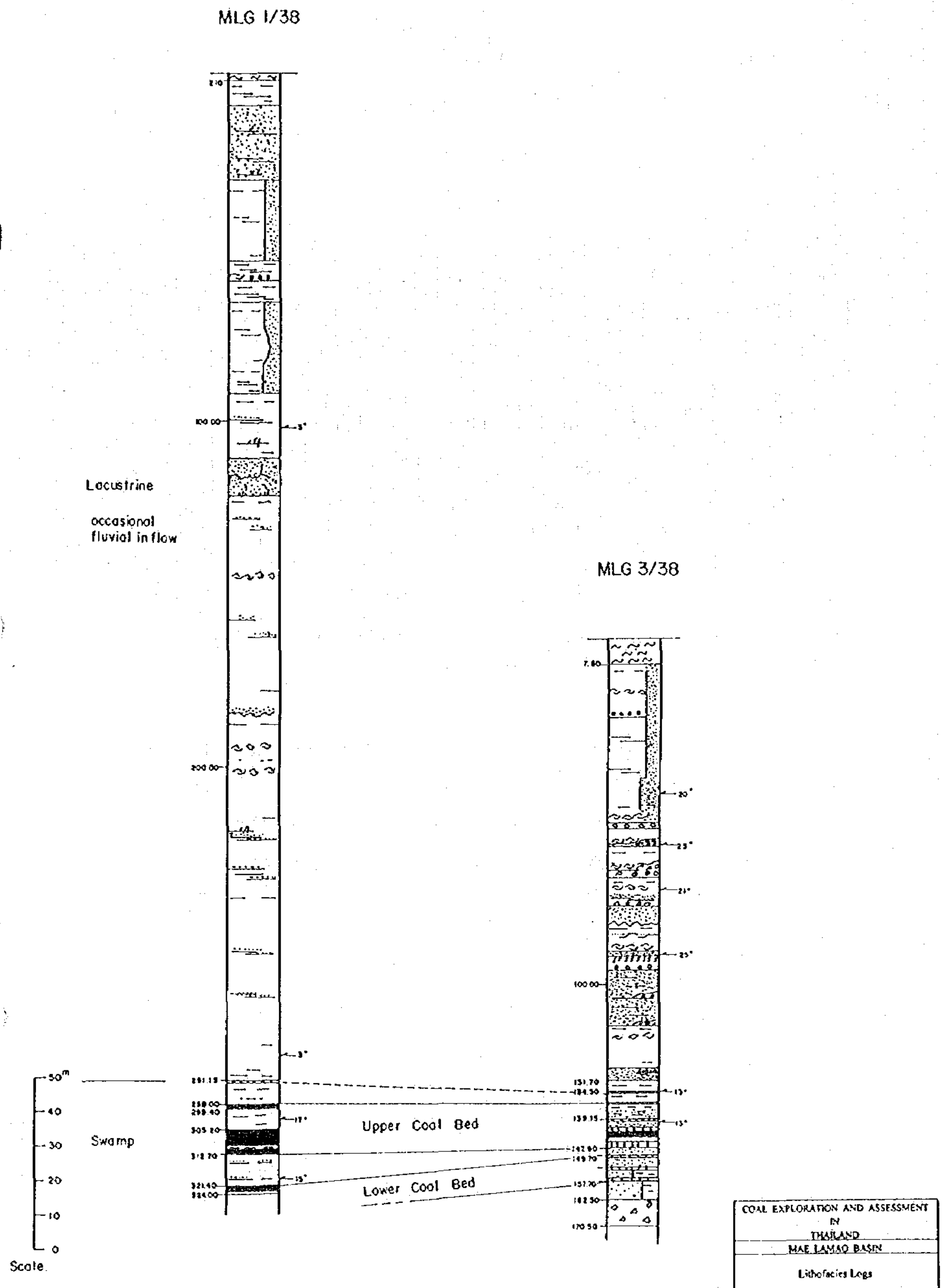
		1993	1994	1995	Total
Drilling	(holes)	-	25	25	50
total depth	(m)	-	4,690.0	3,932.7	8,622.7
Geophysical Logging	(holes)	-	8	13	21
Seismic Survey	(lines)	8	-	11	19
total length	(km)	15.6	-	23.2	38.8
Coal Analysis	(samples)	190	-	189	379

(2) Geological investigation

- Cores of six boreholes are logged by the Study Team.
- Lithologic logs of all boreholes are correlated.
- Coal bed sections are drafted from lithologic logs .
- Geological structure is interpreted from seismic and borehole data.
- 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.



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


MLG 1/38
MLG 3/38
Lacustrine
occasional fluvial inflow
Swamp
Upper Coal Bed
Lower Coal Bed
Scale
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Lithofacies Logs

3.3.3 Geology

(1) Stratigraphy

Tertiary formation of the basin is divided into three members.

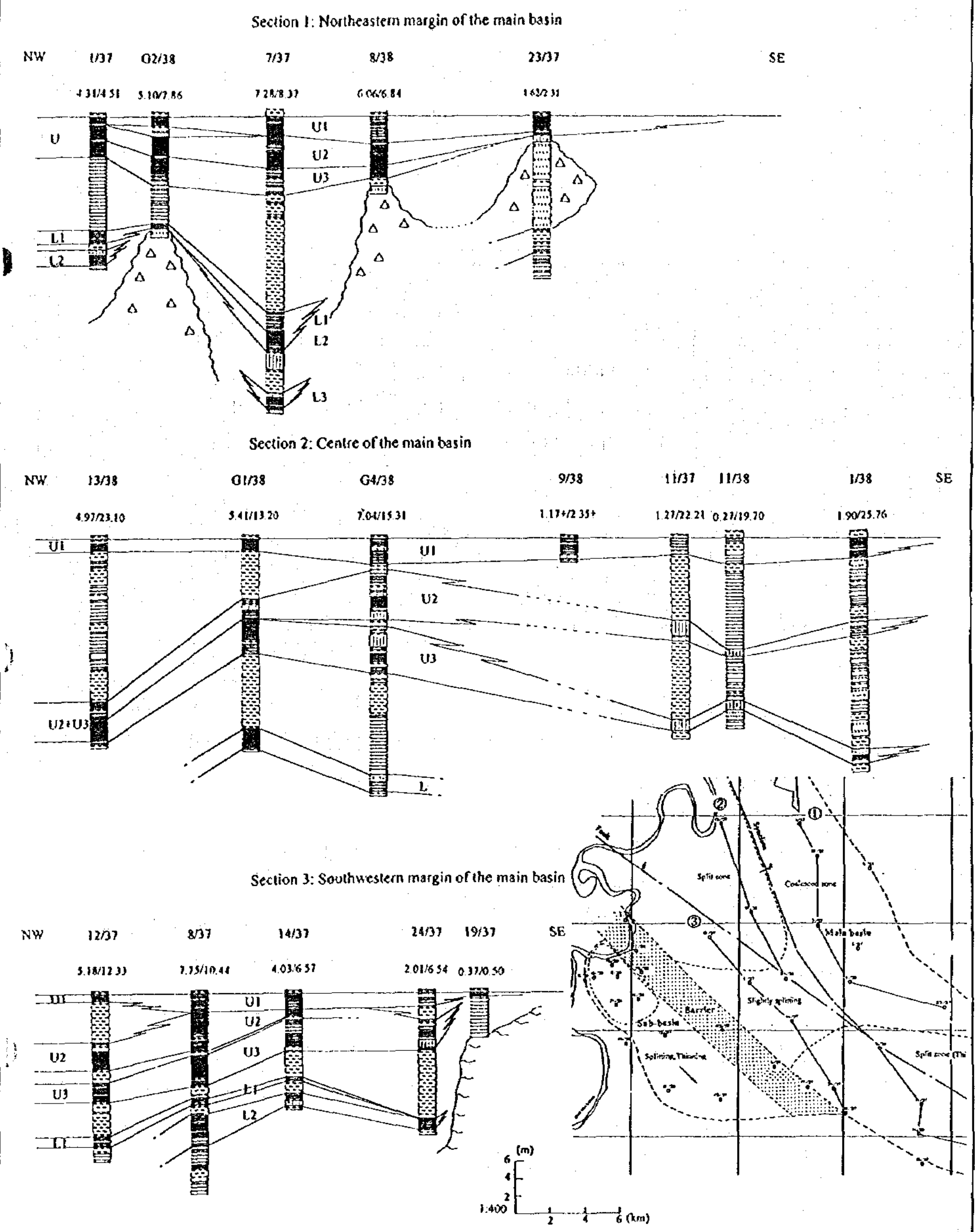
The upper member mainly consists of lacustrine mudstone intercalated with minor sandstone bands. Molluscan fossils are found throughout the member. Middle member is a coal-bearing zone. Several coal beds are present within the deposits of fine grained clastics. Splitting and coalescence of coal beds are common. The lower member consists of coarse clastics such as conglomerate and sandstone and is underlain by basement rocks unconformably.

(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). 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 coalesced without thick partings. Splitting trend is observed toward southeast resulting thinning and deterioration of each coal ply.

(3) Geologic structure

In general, the Mae Lamao Basin forms a broad synclinal structure, of which axis extends 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 divides the small subbasin in the western from the main basin in the east. Two faults are presumed in the main basin which may join to the syncline axis to the south.



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. 3.3.3

(4) Sedimentary environment

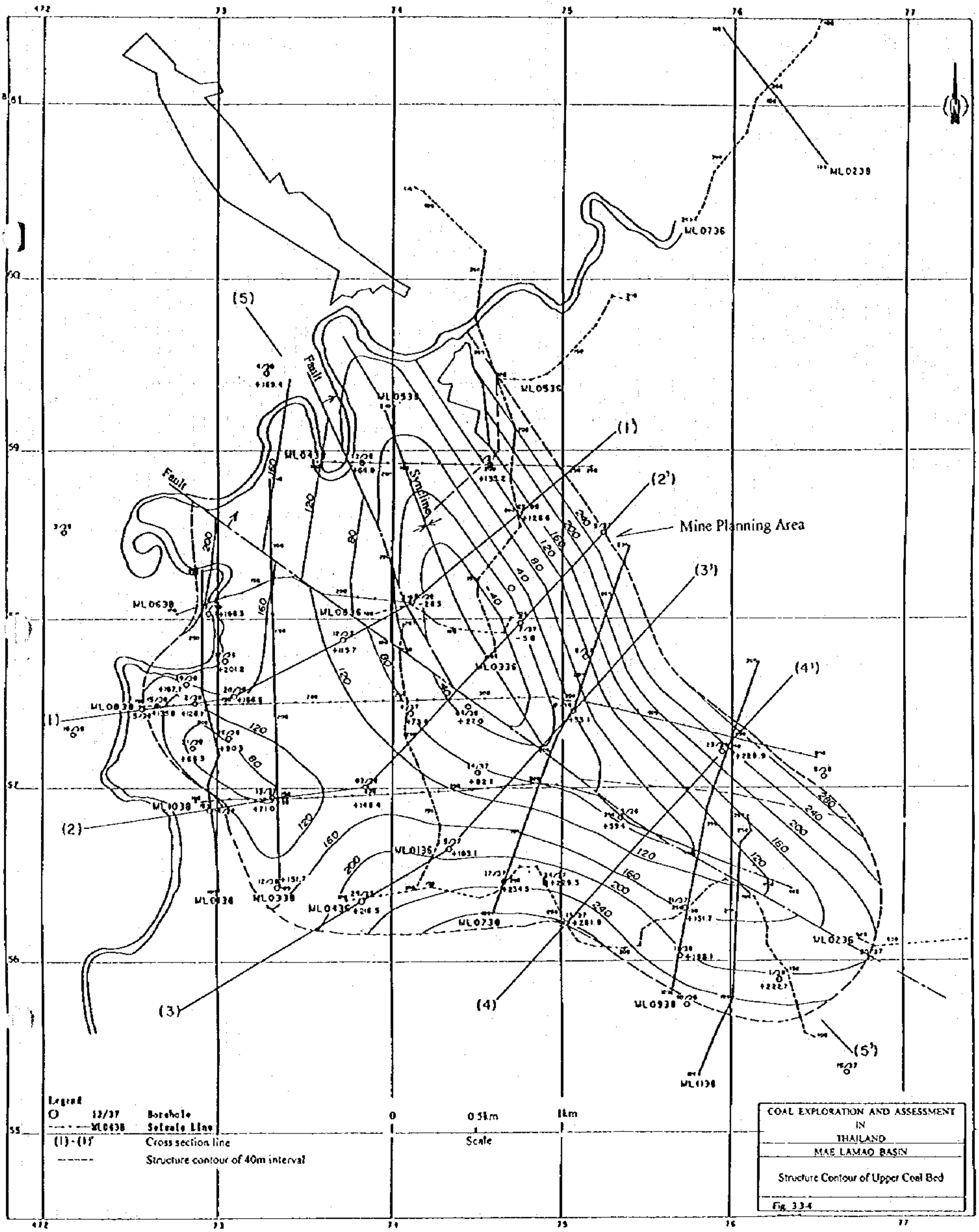
Stratigraphy of the basin indicates similarity to the typical coal-bearing formation in Thailand. Occurrence of coal beds also indicates similarity to those of already developed coal basins such as Li Basin, where the thicker coal beds were deposited in the confined areas in the basin. The confined areas 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 subbasin, 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.

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.



Mine Planning Area
Fault
Syncline
Legend
Borehole
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. 3.3-4

(5) Coal resources and reserves

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. 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.

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 is estimated at 13,993,000 t, which includes inferred reserves of 2,392,000 t.

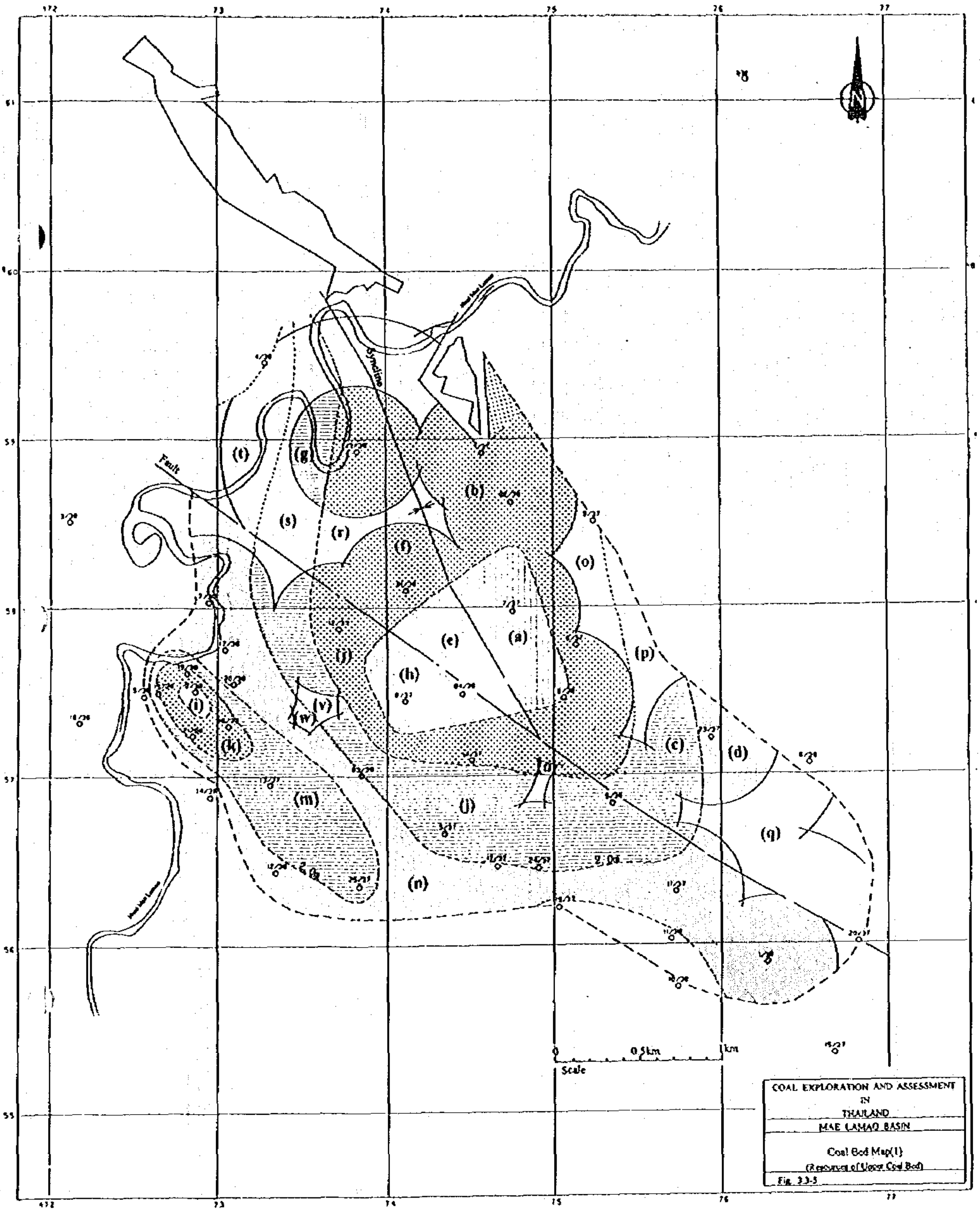

Fault
Syncline
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
(m)
(n)
(o)
(p)
(q)
(r)
(s)
(t)
(v)
(w)
0
0.5km
1km
Scale
COAL EXPLORATION AND ASSESSMENT
IN
THAILAND
MAE LAMAO BASIN
Coal Bed Map(1)
(Reserves of Upper Coal Bed)
Fig. 3.3-5

Table 3.3-2 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 3.3-3 Coal Reserves of 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 in 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.

(1) Basic conditions

1) Mine planning 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 and in shallow depth.

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 openpit mine.

3) Mining thickness

The thickness of the Upper Coal Bed in the mining plan 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.

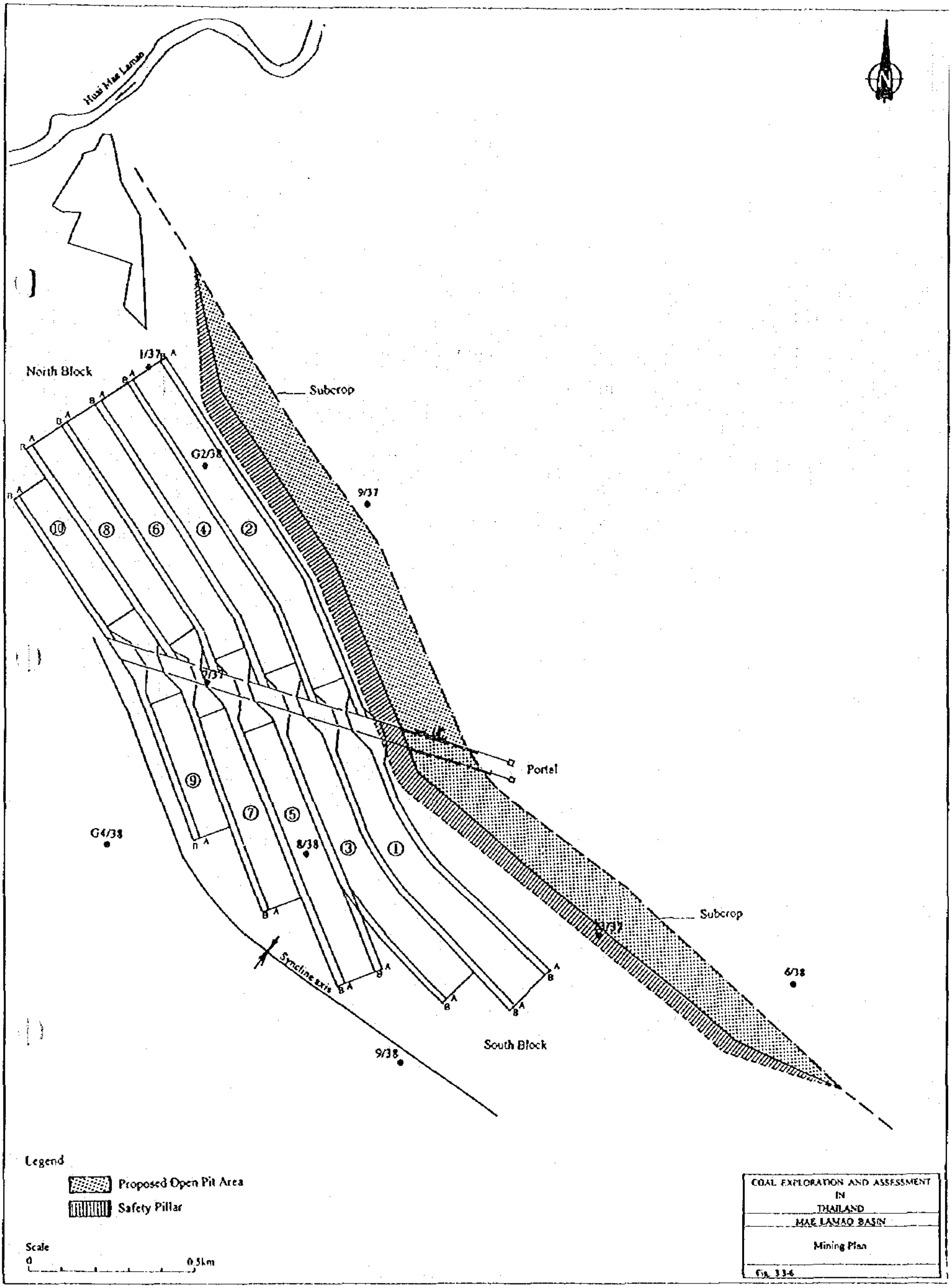
4) Mineable reserves

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.

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

Open pit : 2,549,000 t

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


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

(2) Mining system

1) Open pit mine

The mining operation is planned by multiple bench system with such mobile equipment as bulldozers, front-end loaders, back-hoes, and dump trucks. The depth of the final pit bottom is approximately 60 m from the surface.

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.

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.

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

d) Transportation

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)

3) Work force

a) Open pit mine

	Workers	Staffs	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	Staffs	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.-4 Production Schedule - Mae LamaoU/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
U/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.

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	:	350,050
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 $/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$/t

(5) Surface environment

The surface of the mine planning area is mainly utilized for corn field with sparse paddy field near the streams. 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.

(6) Coal quality

1) Mining thickness

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.

3) Quality of product coal

The quality of final product is estimated on the assumption that 80% of mudstone is removed by screening and hand-picking. The estimated product coal quality of both open pit and underground mines is summarized in Table 3.3-6, -7 and -8.

Table 3.3-5 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	MOST				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	MOST				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
		MOST				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	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	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
	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	MOST				0.18																
MLG	2 /38	C				1.19																
	2 /38	CSH				0.57																
	2 /38	MOST				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	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
U/G	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
	MOST	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 3.3-6 Coal Quality of Mae Lamao Proposed O/P Mine

hole No.		sample No.					as analysed basis								dry basis						ASTM class	
				from	to	thick	SpGr	M	ASH	VM	FC	(FR)	CV	TS	SpGr	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	25.08	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	1.606	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	1.830	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	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	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	9383	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																

hole No.		sample No.				thick	as analysed basis								dry basis						ASTM class	
				from	to	thick	SpGr	M	ASH	VM	FC	(FR)	CV	TS	SpGr	ASH	VM	CV	TS	TSmr/kcal	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																

			as mined basis								dry basis						ASTM class	
		thick	SpGr	M	ASH	VM	FC	(FR)	CV	TS	SpGr	ASH	VM	CV	TS	TSmr/kcal	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.

Coal Database

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.

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.

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". "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. The database should have function called "Report" which is the tool for data presentation in the form of hard copy.

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".

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

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

1) Reliable and available application software the (the Approach, Lotus Smart Suite '97) is selected for easy operation, easy data retrieval and analysis.

2) Application of a lithological coding method for simplification.

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.

4.2.2 Data combination (Structure of data)

Whole lithological code names and the structure of data combination are shown in Fig. 4.2-1.

4.2.3 Hardware component

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

HP Designjet 600 Plotter (A0 Size)

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. 4.2-2.

4.2.5 Data entry

On the 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. 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.

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
Report 2: Current Record
Report 3-1: Stratum List (Borehole)
Report 3-2: Stratum List (Basin)
Report 4: Lithologic Report
Report 5-1: Summary (All)
Report 5-2: Summary (Basin)
Report 5-3: Summary (Borehole)

(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.

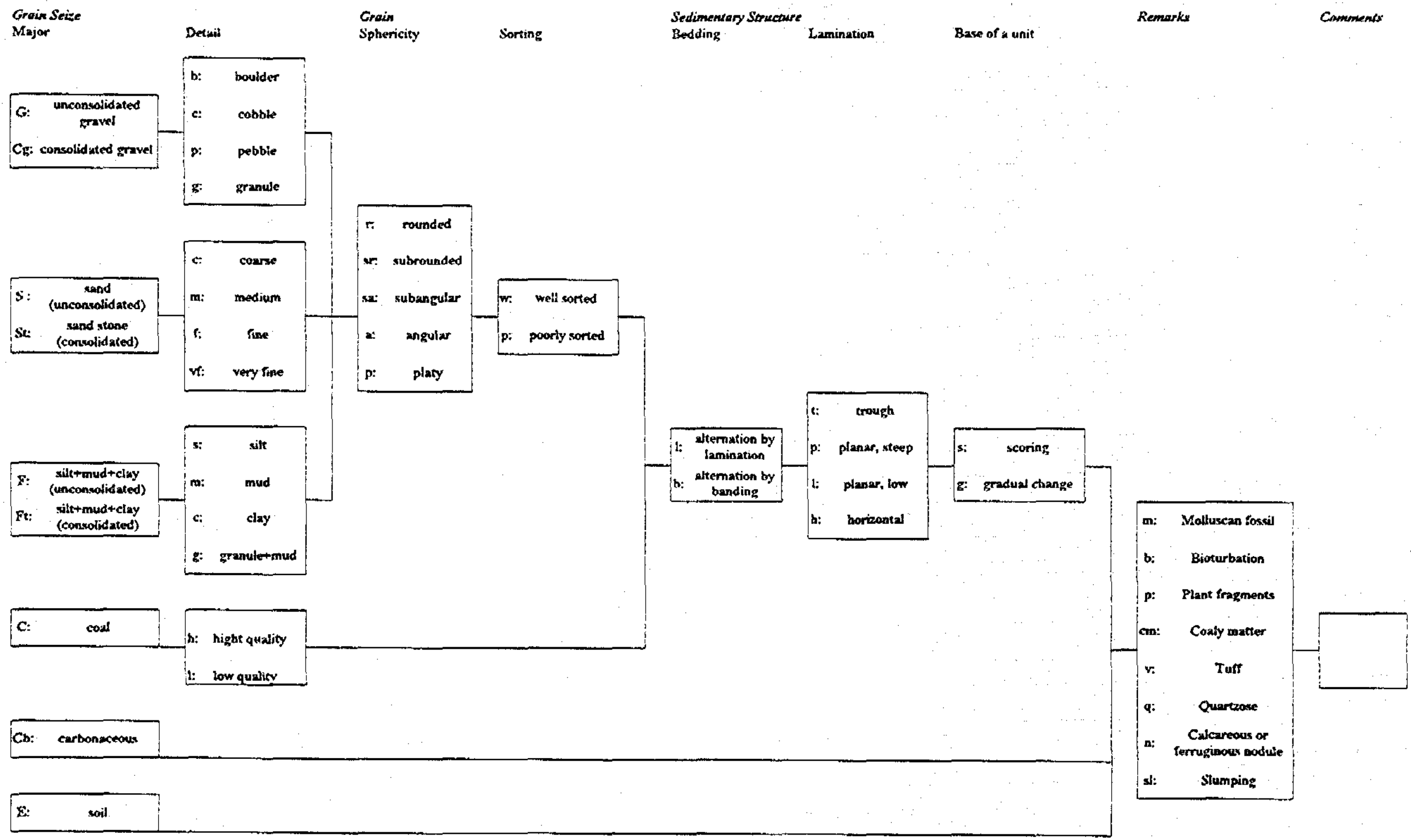


Fig. 4.2-1 Data Coding and Combination

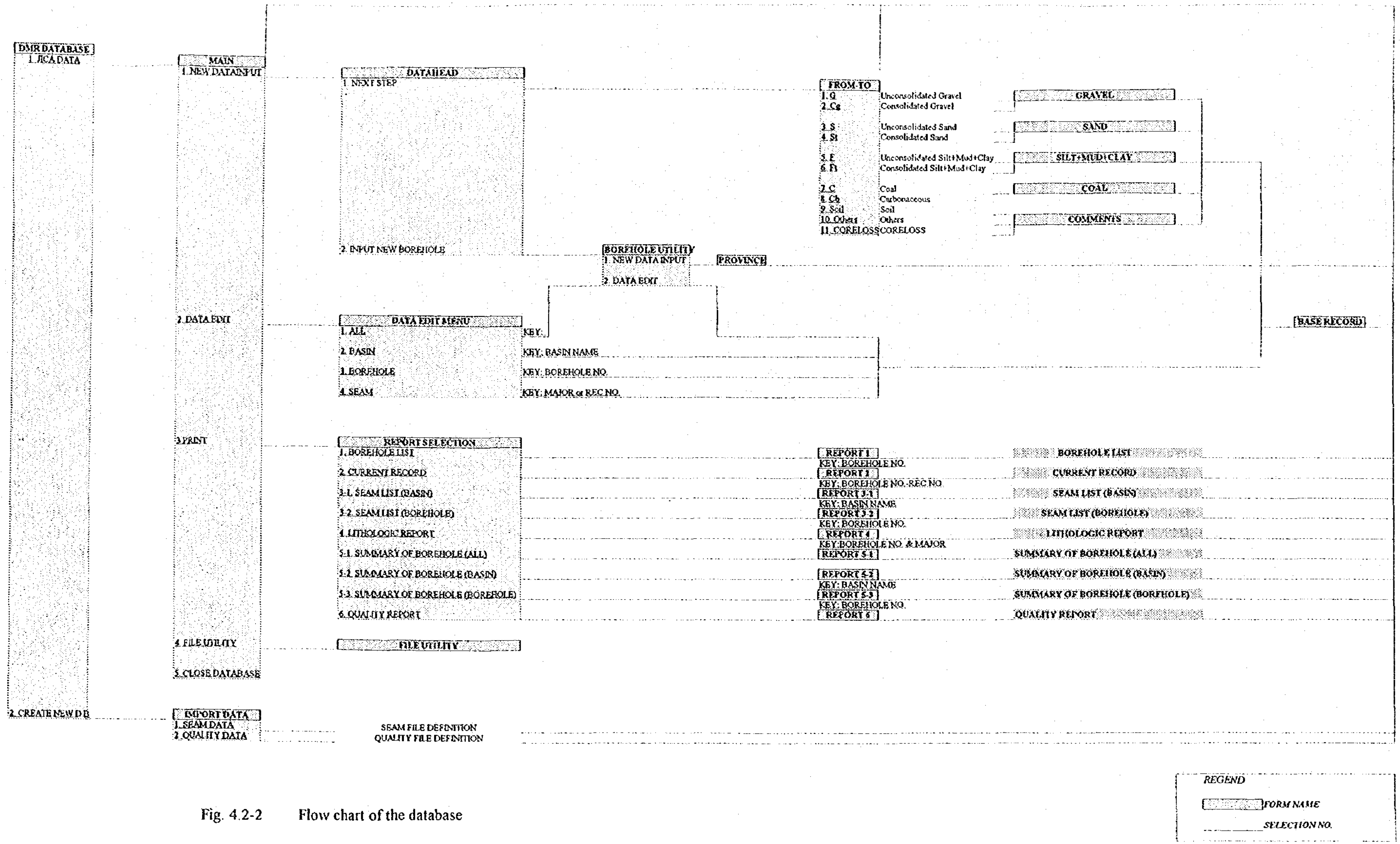


Fig. 4.2-2 Flow chart of the database

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.

(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. Therefore it is necessary to recognize that each datum has significant value and shall be obtained and treated with maximum attention.

(4) Each technical field

I. Exploration technology (Improvement and New technology)

1) Outcrop survey and route mapping (Improvement)
2) Description of lithology (New technology)
3) Interpretation of logging and seismic survey data (Improvement)
4) Basin analysis technology (New technology)

II Technology for geological database (New technology)

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

IV Technology for underground coal mine development (New technology)

5.2 Practice of technology transfer

(1) Planed technology transfer

Technology transfer for the counterpart executed with seminar and training at the initial stage were as follows:

(P:Phrae, N:Nong Plab, M:Mae Lamao, D:DMR's office, J:Japan)

• Outcrop survey and geological mapping	PNJ
• Description of lithofacies applicable for data base	PNMDJ
• Visual logging of the borehole cores	PNM
• Drafting the borehole logs and correlation	PNMDJ
• Analysis of geologic structures	DJ
• Interpretation of the geophysical logs	DJ
• Interpretation of the seismic profiles	DJ
• Sampling of the coal beds	PNMD
• Coal geology	DJ
Origin of coal and coalification	
Depositional environment of the coal bed	
Tectonics of the coal basin	
Sedimentary structures of the coal beds	
Basin analysis technology	
• Geological data base	D
Programming of data base	
Operation of data base	
• Coal quality analysis	D
Information for coal quality evaluation standard	
Operation of coal quality analysis equipment	
• Underground coal mining	DJ

Mining methods

Mining facilities

Mine safety, counter measures for risk

Mining plan

Beneficiation of coal

- Estimation of quality of the coal product D

(2) Comprehensive analysis and application of the obtained geologic data

The Study Team practiced intensive technology transfer regarding to analyze the obtained geological data. The Study Team explained and demonstrated the procedure of geological analysis and estimation of the resources, reserves and mineable coal reserves. They are as follows:

- Adjustment of the visual log of the borehole to the geophysical logs (New technology)
- Adjustment of the data of coal bed (New technology)
- Drafting of borehole logs of various scale (Improvement)
- Correlation of the seismic reflectors and borehole logs (New technology)
- Drafting of the geological profiles (New technology)
- Drafting of the coal bed section (Improvement)
- Drafting of the coal bed maps (Improvement)
- The resources, reserves are estimated on these coal bed maps delineating the geologic assurance areas. (Improvement)
- These coal bed maps are utilized for mining plan (New technology)
- The mineable coal reserves are estimated on the mining plan. (New technology)
- The feasibility of a mine development is evaluated comparing the investment and cost estimated by mining plan to the price of the produced coal. (New technology)

5.3 Results

5.3.1 Immediate results

(1) Effective coal analysis

Coal analysis equipment supplied by JICA were installed in DMR's laboratory and fully utilized. Their capacity of analysis increased ten times efficient compared to the previous ones, and the problem of inefficient analysis was solved. This improvement makes prompt analysis. It improves avoiding change in conditions of samples for various kinds of analysis, especially in moisture contents .

(2) Presentation of the results of the Study in the International Conference

During the Study, the Study Team summarized the stratigraphy of the Phrae Basin. The "Phrae Formation" is proposed to denominate the Tertiary formation owing to the difference in lithofacies from the Mae Moh Basin, which represents the standard stratigraphy of the Tertiary intermontane basins in the northern Thailand. DMR organized the International Conference and requested JICA to present the results of investigation to the conference. JICA agreed it and dispatch Mr. Jiro Muraoka, the leader of the Study Team, to the conference, and he made a presentation. It means that a part of technical transfer was executed not only for DMR personnel but also for the society of Thai geologists.

(3) Three scholarship master course students to foreign universities

Mr. Phumi Srisuwan, Mr. Kriangkrai Phomin and Miss Aree Rittipat, are members of the counterpart study team. They accomplished the Study with the Study Team and are transferred significantly important technology and absorbed invaluable experience and know-how from Japanese experts. The two persons of them are participants of the counterpart training of JICA during the Study period in Japan.

They challenged the examination of scholarship for the student study abroad and passed it. Mr. Phumi Srisuwan was accepted his applications for basin analysis by the London University, Mr. Kriangkrai Phomin by the South Dakota University and Miss Aree

Rittipat by the Pennsylvania State University. They left Thailand for the U.K. and the U.S. and started their study in the master course of each university.

5.3.2 Results of technology transfer

The estimation of the results of technology transfer is very difficult, however JICA and DMR study teams attempt to it and is shown in Table 5.3-1.

Table 5.3-1 The Comparison of transferred technology between before and after the Study

Transferred Technology	Before the Study in DMR	After the Study in DMR (Evaluation of transfer)
I. Exploration technology		
1) Outcrop survey and route mapping	Need Improvement	All geologists of DMR study team apply the technology to their job.
2) Description of lithology with lithofacies cod system	Non	All geologists of DMR study team aquired and some of them aplly it to their job
3) Criteria for exploration works such as sampling	Need Improvement	All geologists of DMR study team apply the technology to their job
4) Interpretation of logging and seismic survey data	(Need Improvement)	
• Manual interpretation of geophysical logs depending on basic theory	Non	About half of geologists of DMR study team can apply the technology to their job
• Adjustment of the visual log of the borehole to the geophysical logs	Non	All geologists of DMR study team apply the technology to their job
• Adjustment of the data of coal bed to the analysis results.	Non	About half of geologists of DMR study team can apply the technology to their job
• Drafting of borehole logs of various scale	Need Improvement	All geologists of DMR study team apply the technology to their job
• Correlation of the seismic reflectors and borehole logs	Non	About half of geologists of DMR study team can apply the technology to their job
• Drafting of the geological profiles	Non	About half of geologists of DMR study team can apply the technology to their job
5) Estimation resources, etc. and quality of the product	(Need Improvement)	
• Estimation of resources, reserves on these coal bed maps	Non	About half of geologists of DMR study team can apply the technology to their job
• Estimation of mineable coal reserves on the mining plan.	Non	About half of geologists of DMR study team can apply the technology to their job
• Estimation of quality of the coal product	Non	About half of geologists of DMR study team can apply the technology to their job
6) Basin analysis technology	(Non)	
• Drafting of the coal bed section	Non	About half of geologists of DMR study team can apply the technology to their job
• Drafting of the coal bed maps	Non	About half of geologists of DMR study team can apply the technology to their job
II Technology for geological database		
1) Programming of data base	Non	A few specialist of DMR can apply the technology for their job
2) Operation of data base	Non	Members of DMR study team can use the technology by themselves
III Technology for coal quality analysis		
1) Information for coal quality evaluation standard	Need Improvement	Members of DMR study team can use the technology by themselves
2) Operation of coal quality analysis equipment	Non	A few specialist can operate equipment, however results of analysis are utilized in DMR
IV Technology for underground coal mine development		
1) Mining methods	Non	A few specialist of DMR can apply the technology for their job
2) Mining facilities	Non	A few specialist of DMR can apply the technology for their job
3) Mine safety, counter measures for risk	Non	A few specialist of DMR can apply the technology for their job
4) Mining plan	Non	A few specialist of DMR can apply the technology for their job

5.4 Practice of transferred technology in DMR

Owing to considerable difference between the conventional exploration method and transferred technology in addition to only a few existing experienced geologists, DMR may be not possible to practice exploration totally with transferred technology right now. But DMR's ongoing plan to expand its function to development enforces to practice exploration with transferred technology. Because, the conventional technology is not enough, and the transferred technology is needed for the development of the resources. Actually DMR is going to adopt lithofacies coding method transferred by the Study Team for the convenience and effectiveness. And they intends to adopt other transferred technology.

5.5 Conclusions and recommendations

5.5.1. Conclusion

(1) Completed planed technology transfer

It is not exaggeration to say that the undertaking of technology transfer on the Study was carried out as planed and we obtained satisfactory results. From a series of on the job training, seminar and especially counterpart training in Japan, participants of the training have had a lot of instructive and interesting experience. DMR has systematic and effective technology of exploration, evaluation, geological database, coal quality analysis for coal development, now.

(2) Effective exploration results for development

Through the Study, the Study Team transferred how to utilize and analyze the obtained geological data comprehensively. However DMR was not familiar with the development especially planning of it. According to DMR's expansion plan, DMR will be in charge of the development in the near future. For this expansion plan, it is very necessary to learn how to utilize and analyze the obtained data by themselves. Otherwise they can not obtain the effective geological data. The counterpart members understood the transferred technology of exploration and underground mining through the joint work with the Study Team. However, exploration needs long period of two or three years with continuous devotion f or the work. And also the inexperienced geologic phenomena which have not been experienced throughout the Study will occur in general. Therefore it necessitates the further study, which comprise from exploration to feasibility study. In which exploration shall be conducted by the DMR's member under the assistance of the experienced mining geologists, and the feasibility study shall be conducted cooperatively with the experts and DMR's members. Hence the members of DMR will be able to learn and experience by themselves what is the necessary geological data for development.

5.5.2. Recommendation

DMR believes it is essential to improve it's previous technology to the technology transferred from the Study Team of JICA. Also DMR believes it is very necessary to learn and acquire the capability of assessment of the resources development plans or project. In order to meet these needs, it is recommended to execute a feasibility study on an appropriate coal basin requesting JICA a new international cooperative study.

JICA