3.2.1 Preparation of Sample

(1) Main Coal Beds

Six samples (PH3, N1-3, N3-4, N3-6, N5-1, N5-13) were sent to the laboratory of Lanna Lignite Company at Li and crushed to smaller than one inches. The three quarters of each sample were used for float-sink test at Lanna's laboratory and the remains were sent to Mae Moh's laboratory of EGAT for various quality analyses.

(2) Other Coal Beds

Other coal samples from the boreholes were sent EGAT for various quality analyses except float-sink test.

3.2.2 Analysis and Tests

(1) Main Coal Beds

After screening with the mesh of 10mm and 0.5mm, products of 0.5-10mm and +10mm were used for float-sink test. Separation density used in the test was 1.35, 1.40, 1.50, 1.60 and 1.80, taking account of the test result of bulk sample.

Each portion separated by density and products of under 0.5 mm were analyzed on total sulfur content at Lanna's laboratory and then, 25g each of them were sent to EGAT's laboratory for coal quality analyses. Analytical items were proximate analysis, calorific value, ultimate analysis, ash analysis, hardgrove grindability index (HGI) and forms of sulfur.

The results of float-sink test with ash and total sulfur contents conducted in Lanna's laboratory were attached in Appendix 6. A part of the results of coal analysis and tests conducted in EGAT's laboratory were shown on Table 3-3.

(2) Other Coal Beds

The following analyses were conducted by EGAT; proximate analysis, calorific value, ultimate analysis, ash analysis, forms of sulfur and specific gravity.

The result is shown on table 3-4.

3.3 Coal Quality

The quality of Ngao coal is variable place by place. There are two main causes; (1) Peat deposition might be occurred in each sub-basin separately. (2) Those peat swamps were presumed as “planar peat” (Cecil, et al, 1985).

Coal analytical data from twenty-one (21) boreholes are available for this study, although 113 boreholes including five holes done during this exploration period have been conducted in Ngao Coal basin. The numbers of data (21 holes) is sparse for the area as large as 13km^2 where coal zones exists within the depth shallower than 250m from the ground surface. A preconception about Ngao coal as very high sulfur contents was so intense. There was no chemical analysis data on the form of sulfur in Ngao basin.

The previous coal analysis data and the analysis result this time are shown in Table 3-3 and Table 3-4 respectively. Iso-value map on ash content, calorific value and total sulfur content on dry basis are illustrated in Figure 3-3 to Figure 3-5.

Coal quality in Ngao area is outlined based on the coal analysis data taken from 21 boreholes in this chapter. The Ngao coal is discussed later in detail in the quality upgrade technology of Chapter 4.

As mentioned before, two coal zones (Zone I and Zone II) are recognized in Ngao area. There is not much difference in the proximate analysis between Zone I and Zone II as shown in Table 3-5. The following descriptions are about Zone I, because the mining plan was carried out on Zone I.

Table 3-3 Previous data on Coal Quality

	From	To	Thickness (m)	Moisture (ar) %	Ash (ar) %	V.M. (ar) %	F.C. (ar) %	H.V. (ar) kcal/kg	S (ar) %	SG
NG 16/40	131.55	132.55	1.00	27.61	28.12	29.01	15.26	2,473	5.29	1.476
	132.55	133.55	1.00	25.98	28.21	31.08	14.73	2,499	6.29	1.452
	133.55	134.55	1.00	26.97	23.88	32.49	16.66	2,445	7.99	1.534
	134.55	136.00	1.45	23.86	40.21	31.80	4.13	2,077	6.57	1.522
	136.00	136.80	0.80	26.64	35.12	28.29	9.95	1,830	7.02	1.554
	136.80	137.80	1.00	31.04	23.35	30.10	15.51	2,685	5.39	1.466
	137.80	138.40	0.60	27.57	30.97	33.16	8.30	2,491	5.72	1.302
	138.75	139.65	0.90	31.79	22.74	29.29	16.18	2,772	4.29	1.303
	141.15	141.95	0.80	29.48	26.27	31.88	12.37	2,270	6.54	1.301
	145.00	146.00	1.00	28.89	30.96	27.84	12.31	2,211	5.04	1.367
	146.00	146.30	0.30	26.56	39.68	25.42	8.34	1,553	5.06	1.476
	147.35	147.65	0.30	31.51	26.51	28.58	13.40	2,462	4.80	1.321
	148.05	148.40	0.35	31.59	22.67	29.87	15.87	2,525	5.12	1.278
	149.05	150.00	0.95	26.32	34.23	28.15	11.30	2,027	5.68	1.448
	150.40	150.80	0.40	26.83	34.64	28.28	10.25	2,118	5.24	1.485
	152.55	153.00	0.45	23.74	33.30	31.06	11.90	1,946	8.81	1.608
	211.35	212.00	0.65	33.43	24.06	29.33	13.18	2,627	4.44	1.402
	213.40	213.85	0.45	27.40	33.99	28.15	10.46	2,008	5.48	1.504
NG 3/40	216.90	217.20	0.30	20.33	38.76	31.95	8.96	1,577	8.11	1.747
	217.30	217.74	0.44	18.37	45.82	33.17	2.64	1,576	8.35	1.702
	218.65	218.95	0.30	27.02	33.24	30.81	8.93	1,952	5.51	1.529
	220.55	220.95	0.40	26.94	31.54	32.92	8.60	1,975	6.40	1.459
	222.27	222.60	0.33	25.54	32.63	31.46	10.37	2,198	4.74	1.456
	225.70	226.00	0.30	21.32	43.06	31.96	3.66	1,734	7.39	1.611
NG 4/40	236.76	237.30	0.54	20.70	41.34	29.84	8.12	1,815	4.09	1.565
	239.17	240.17	1.00	20.81	33.38	31.98	13.83	2,212	4.34	1.511
	240.17	241.05	0.88	32.10	17.14	31.00	19.76	3,207	2.97	1.336
	242.60	243.60	1.00	28.60	27.96	28.66	14.78	2,485	2.94	1.447
	243.60	243.97	0.37	24.00	36.96	28.24	10.80	2,057	6.18	1.571
	244.00	245.00	1.00	22.23	42.88	27.52	7.37	1,763	4.08	1.620
	245.00	246.00	1.00	22.85	34.75	29.99	12.41	2,155	5.53	1.551
	246.00	247.00	1.00	28.86	26.99	29.04	15.11	2,784	2.60	1.437
	247.00	248.00	1.00	31.48	19.25	29.67	19.60	3,118	2.41	1.363
	248.00	248.30	0.30	22.59	52.87	18.96	5.58	1,180	1.36	1.723
	248.58	249.58	1.00	23.97	37.59	28.27	10.17	1,886	5.21	1.565
	249.58	249.95	0.37	26.04	27.93	31.66	14.37	2,632	4.46	1.419
	251.00	252.00	1.00	22.05	42.25	26.48	9.22	1,878	2.97	1.630
	253.86	254.26	0.40	21.19	48.19	23.29	7.33	1,606	2.29	1.719
	254.47	255.50	1.03	24.74	29.78	31.62	13.86	2,494	3.93	1.492
	256.19	257.19	1.00	21.44	38.19	30.42	9.95	1,967	5.24	1.561
	258.95	259.76	0.81	26.18	28.92	31.11	13.79	2,390	5.11	1.471
	260.00	260.75	0.75	22.37	43.09	26.92	7.62	1,846	3.86	1.682
	261.07	262.58	1.51	24.83	32.92	29.27	12.98	1,330	5.01	1.614
	327.08	328.08	1.00	22.32	37.27	30.25	10.16	2,303	4.01	1.567
	328.08	329.08	1.00	21.22	36.29	31.07	11.42	2,393	4.71	1.531
	329.08	329.73	0.65	20.04	50.14	22.74	7.08	1,464	3.11	1.710
NG 10/40	179.75	180.15	0.40	9.62	41.29	34.33	14.76	2,502	11.45	1.921
	180.15	181.15	1.00	12.98	50.98	35.51	0.53	2,105	8.11	1.740
	181.15	181.55	0.40	14.47	26.60	35.97	22.96	3,358	4.84	1.516
	182.85	183.15	0.30	10.48	49.71	31.89	7.92	2,294	5.02	1.752
	184.50	185.00	0.50	16.71	40.88	32.64	9.77	2,384	6.60	1.558
	185.90	186.35	0.45	16.70	36.59	33.93	12.78	2,296	8.76	1.539
	186.60	187.15	0.55	27.98	22.39	32.27	17.36	2,887	6.56	1.382
	187.40	188.00	0.60	26.18	26.98	32.02	14.82	2,621	6.23	1.415
	189.90	190.30	0.40	26.31	29.69	30.63	13.37	2,371	6.21	1.377
	192.00	192.50	0.50	27.52	29.80	30.36	12.32	2,457	7.16	1.381
	193.90	194.30	0.40	19.54	30.08	34.58	15.80	2,333	10.56	1.472
	195.35	196.40	1.05	22.56	28.93	32.26	16.25	2,445	7.75	1.418
	197.50	198.20	0.70	25.69	27.71	33.75	12.85	2,898	5.42	1.357
	200.75	201.40	0.65	32.04	22.43	28.77	16.76	2,603	5.17	1.314
NG 12/40	247.15	248.15	1.00	23.68	36.92	27.84	11.56	2,201	5.16	1.602
	248.15	249.15	1.00	26.03	33.07	26.85	14.05	2,297	4.53	1.545
	249.15	250.20	1.05	20.66	42.44	25.50	11.40	2,040	3.62	1.608
	251.70	252.10	0.40	17.86	38.36	29.53	14.25	2,600	2.60	1.602
	255.30	255.65	0.35	8.65	54.78	26.22	10.35	2,029	4.29	1.918
	256.05	257.00	0.95	8.04	54.16	26.93	10.87	2,155	2.79	1.932
	260.40	261.40	1.00	16.30	44.86	28.74	10.10	2,128	4.28	1.721
	262.72	263.40	0.68	20.40	39.93	26.79	12.88	2,116	4.42	1.597
NGG 1/40	74.30	75.15	0.85	21.98	33.08	33.29	11.65	2,050	8.04	1.525
	75.40	76.25	0.85	28.41	22.07	31.99	17.53	2,638	5.48	1.449
	77.00	78.00	1.00	29.48	22.23	31.30	16.99	2,665	5.66	1.381
	79.95	80.00	0.05	29.91	25.68	29.76	14.65	2,424	4.42	1.443
	81.35	81.85	0.50	27.73	27.05	30.97	14.25	2,530	3.46	1.436
	82.60	83.35	0.75	26.66	26.80	31.41	15.13	2,481	4.59	1.414
	134.30	135.70	1.40	27.48	27.60	29.50	15.42	2,513	3.36	1.459
	134.30	135.70	1.40	24.92	28.40	30.44	16.24	2,563	3.32	1.482
	135.90	136.85	0.95	19.26	36.99	37.83	5.92	2,358	8.00	1.473
	137.15	138.35	1.20	23.88	28.74	30.82	16.56	2,545	3.82	1.427
NGG 2/40	96.80	97.20	0.40	27.03	26.95	33.79	12.23	2,152	7.84	1.464
	100.80	101.35	0.55	26.93	25.00	34.53	13.54	2,189	9.19	1.488
	104.75	105.20	0.45	24.57	34.26	30.54	10.63	2,127	5.20	1.570
	181.30	181.70	0.40	25.42	30.37	33.39	10.82	2,549	6.19	1.460
NGG 3/40	156.60	157.10	0.50	21.39	34.88	31.47	12.26	2,058	7.11	1.558
	157.55	158.32	0.77	23.96	35.18	30.34	10.52	2,144	3.59	1.480
	160.90	161.90	1.00	29.87	27.34	29.27	13.52	2,624	2.25	1.388
	161.90	162.20	0.30	31.91	16.42	30.78	20.89	3,261	2.28	1.326
	162.20	162.95	0.75	33.10	11.75	30.97	24.18	3,533	2.04	1.353
	162.95	164.95	2.00	30.96	27.40	28.56	13.08	2,545	2.46	1.454
	164.95	165.95	1.00	29.97	26.45	28.76	14.82	2,616	2.68	1.460
	165.95	166.95	1.00	29.24	25.67	29.07	16.02	2,758	3.21	1.446
	166.95	167.95	1.00	25.96	34.16	28.66	11.22	2,248	3.86	1.583
	167.95	168.95	1.00	22.58	37.49	30.36	9.57	1,842	6.79	1.656
	168.95	169.95	1.00	29.38	22.78	31.07	16.77	2,916	3.50	1.413
	169.95	170.70	0.75	32.67	18.42	29.78	19.13	3,073	1.99	1.396
	171.30	172.30	1.00	23.35	39.36	29.33	7.96	1,711	6.06	1.669
	172.30	172.80	0.50	28.06	26.03	31.97	13.94	2,324	5.30	1.513
	172.95	173.25	0.30	25.58	20.89	34.21	19.32	2,772	7.15	1.413
	175.27	175.75	0.48	27.36	37.96	24.51	10.17	1,763	1.53	1.590
	176.63	177.70	1.07	26.12	35.96	28.23	9.69	1,956	4.37	1.600
	178.90	179.60	0.70	24.14	27.36	32.91	15.59	2,831	4.24	1.470
	180.00	180.90	0.90	20.45	32.91	34.99	11.65	2,338	7.02	1.500
	262.90	263.70	0.80	22.63	27.76	35.11	14.50	2,848	5.77	1.399
	263.80	264.85	1.05	23.25	33.75	30.54	12.46	2,524	4.28	1.491
NGG 4/40	156.30	157.25	0.95	23.81	28.35	31.99	15.85	2,568	6.68	1.868
	158.35	158.80	0.45	22.36	37.24	35.70	4.70	2,261	5.62	1.818
	160.00	160.40	0.40	30.04	18.45	30.89	20.62	3,266	4.05	1.970
	219.55	222.05	2.50	18.94	37.93	31.29	11.84	2,181	6.23	2.140
	223.25	223.95	0.70	22.30	31.84	34.96	10.90	2,380	5.90	1.526

SG*: Specific Gravity of boreholes (/40 series) was calculated by relationship of Ash and SG of other boreholes.

	From	To	Thickness (m)	Moisture (ar) %	Ash (ar) %	V.M. (ar) %	F.C. (ar) %	H.V. (ar) kcal/kg	S (ar) %	SG*
LN 1/21	3.71	4.36	0.65	36.80	25.20	25.60	12.40	2,035	2.59	1.41
	5.18	5.60	0.42	34.90	24.40	27.10	13.60	2,428	2.51	1.40
	9.57	10.10	0.53	34.20	33.20	24.00	8.60	1,721	1.31	1.52
	10.69	10.98	0.29	40.60	19.70	25.10	14.60	2,427	2.60	1.34
	11.88	13.18	1.30	33.40	27.00	25.20	14.40	2,214	3.54	1.44
	15.04	15.59	0.55	29.60	29.80	28.40	12.20	2,337	2.49	1.48
	16.09	16.24	0.15	29.60	39.00	22.70	8.70	1,596	1.47	1.60
	17.59	19.09	1.50	33.10	34.60	24.00	8.30	1,961	1.99	1.54
LN 3/21	36.97	37.50	0.53	35.50	31.10	23.30	10.20	1,881	1.31	1.49
	37.50	38.00	0.50	35.10	31.30	25.10	8.50	1,885	1.51	1.49
	38.00	38.50	0.50	44.10	17.00	26.30	12.60	2,114	2.84	1.31
	38.50	39.00	0.50	43.70	15.90	26.40	14.00	2,396	2.33	1.29
	39.00	39.50	0.50	42.10	14.30	27.30	15.80	2,651	2.55	1.27
	39.50	39.94	0.44	40.90	17.10	28.50	13.50	2,596	2.76	1.31
	41.00	41.50	0.50	36.90	29.70	25.60	7.80	2,033	1.55	1.47
	41.50	42.00	0.50	38.40	23.70	27.00	10.90	2,624	1.97	1.39
	42.00	42.50	0.50	38.00	26.40	26.20	9.40	2,047	1.89	1.43
	42.50	43.00	0.50	41.90	18.40	27.10	12.60	2,268	3.00	1.32
	43.00	43.50	0.50	41.00	25.30	25.70	8.00	1,924	1.76	1.42
	43.50	44.00	0.50	43.40	22.70	23.30	10.60	2,007	1.46	1.38
	44.00	44.58	0.58	38.60	27.90	25.30	8.20	2,020	1.86	1.45
	45.42	45.67	0.25	37.50	28.60	24.60	9.30	2,071	1.43	1.46
	46.00	46.75	0.75	37.50	30.90	27.50	4.10	1,927	1.84	1.49
	47.00	47.52	0.52	43.60	20.50	25.00	10.90	2,313	1.86	1.35
	47.67	48.00	0.33	44.60	18.20	23.60	13.90	2,319	1.77	1.32
	48.00	48.50	0.50	44.70	17.10	25.50	12.70	2,346	2.57	1.31
	48.50	49.15	0.65	43.90	24.00	24.70	11.00	2,348	2.43	1.40
	49.55	50.15	0.60	44.20	19.60	25.30	10.90	2,267	2.00	1.34
	50.80	51.18	0.38	43.60	18.70	25.10	12.60	2,221	1.86	1.33
	51.56	52.00	0.44	34.40	35.90	22.20	7.50	1,425	2.48	1.56
	56.06	57.00	0.94	37.60	27.20	25.20	10.00	2,064	1.16	1.44
	57.00	57.29	0.29	34.00	33.40	23.30	9.30	1,683	1.59	1.52
	57.60	58.02	0.42	32.80	35.00	23.90	8.30	1,611	2.40	1.54
	58.39	58.93	0.54	34.80	35.60	23.30	6.30	1,568	1.66	1.55
	60.03	60.40	0.37	35.60	25.40	26.50	12.50	2,084	1.94	1.42
	62.20	62.75	0.55	43.60	19.30	24.60	12.50	2,185	2.43	1.34
	63.83	64.01	0.18	39.60	25.60	28.00	6.80	2,148	2.29	1.42
	66.42	67.27	0.85	36.40	30.20	26.00	7.40	1,973	1.35	1.48
	68.18	68.59	0.41	40.00	23.80	23.50	12.70	2,158	1.09	1.40
	68.50	70.03	1.53	38.30	25.10	26.30	10.30	1,977	1.48	1.41
	70.03	70.26	0.23	36.20	25.00	24.90	13.90	2,278	1.78	1.41
	75.00	76.68	1.68	32.50	31.60	23.30	12.60	2,106	2.00	1.50
LN 11/21	52.78	53.26	0.48	32.80	27.40	27.60	12.20	2,080	1.82	1.44
	56.53	56.98	0.45	27.60	27.50	28.60	16.30	2,310	6.14	1.44
	68.76	69.20	0.44	30.00	35.60	24.01	10.30	1,945	1.70	1.55
LN 26/21	3.71	4.66	0.95	30.80	28.60	28.00	12.60	2,316	1.62	1.46
	4.76	5.06	0.30	30.30	23.40	31.90	14.40	2,580	4.08	1.39
	5.63	6.29	0.66	31.70	26.80	30.50	11.00	2,497	2.20	1.44
	6.93	7.99	1.06	40.20	30.90	23.30	5.60	1,548	2.37	1.49
	8.14	8.51	0.37	30.30	28.30	28.20	13.20	2,301	2.65	1.46
	10.75	11.05	0.30	31.50	30.00	27.70	10.80	2,039	1.58	1.48
	12.41	12.71	0.30	28.20	36.80	27.80	7.20	1,826	1.79	1.57
	24.02	24.62	0.60	30.00	28.00	30.10	11.90	2,410	1.86	1.45
	46.11	48.23	2.12	32.70	24.30	29.50	13.50	2,446	3.13	1.40
	48.37	49.03	0.66	28.70	28.40	33.40	9.50	2,542	4.67	1.46
LN 27/21	164.10	165.61	1.51	18.30	53.70	20.10	7.90	1,212	3.86	1.79
	170.81	171.41	0.60	24.10	49.90	21.80	4.20	1,324	2.43	1.74
LN 28/21	3.96	4.82	0.86	39.30	21.70	28.30	10.70	2,455	2.57	1.37
	5.22	6.85	1.63	37.30	20.80	26.30	15.60	2,566	2.88	1.36
	7.01	7.90	0.89	29.60	29.80	30.80	9.80	2,457	2.38	1.48
	8.53	9.53	1.00	24.90	30.50	30.30	14.30	2,653	2.70	1.48
	10.53	12.28	1.75	35.70	24.10	27.60	12.60	2,541	2.83	1.40
	13.05	13.19	0.14	37.00	20.00	28.80	14.20	2,660	4.14	1.35
	17.47	18.28	0.81	32.40	27.40	25.70	14.50	2,408	3.46	1.44
	19.47	20.07	0.60	33.40	30.30	26.30	10.00	2,111	2.09	1.48
NG 3/31	106.63	106.75	0.12	9.42	51.24	27.17	12.17	1,715	4.77	1.76
	107.60	107.70	0.10	9.27	53.70	26.71	10.32	2,082	2.93	1.79
	109.40	109.50	0.10	5.29	69.06	23.97	1.68	1,292	4.03	1.99
	112.50	112.60	0.10	10.30	62.16	20.54	7.00	1,405	2.63	1.90
	113.50	113.60	0.10	11.95	57.84	22.12	8.09	1,464	3.30	1.85
	114.50	114.60	0.10	14.31	36.52	32.10	17.07	2,647	7.37	1.56
	115.50	115.60	0.10	16.19	32.28	37.07	14.46	3,033	5.94	1.51
	116.85	116.95	0.10	23.35	31.61	32.55	12.49	2,979	4.11	1.50
	117.50	117.60	0.10	15.21	46.25	27.93	10.61	2,403	3.15	1.69
	118.80	118.90	0.10	13.39	61.10	19.44	6.07	1,310	1.22	1.89
	121.40	121.50	0.10	10.62	52.19	25.73	11.46	2,025	3.14	1.77
	124.50	124.60	0.10	13.01	46.90	24.78	15.31	2,161	3.82	1.70
	125.60	125.70	0.10	14.11	37.88	31.10	16.91	2,106	5.96	1.58
	163.90	164.00	0.10	11.29	61.55	21.42	5.74	1,391	3.46	1.89
	167.00	167.10	0.10	13.28	49.16	25.80	11.76	1,270	4.48	1.73
	169.50	169.60	0.10	15.48	37.05	31.97	15.50	2,863	4.53	1.57
	170.50	170.60	0.10	13.67	46.74	26.57	13.02	2,328	3.76	1.70
	172.40	172.50	0.10	12.87	38.74	31.22	17.17	2,846	5.10	1.59
NG 7/31	6.00	6.10	0.10	18.17	32.17	33.18	16.48	3,010	5.23	1.51
	7.20	7.30	0.10	19.48	30.14	35.33	15.05	2,655	7.16	1.48
	8.10	8.20	0.10	20.78	37.52	38.32	3.38	2,715	7.20	1.58
	8.95	9.05	0.10	22.92	26.90	34.58	15.60	2,531	6.73	1.44
	11.00	11.10	0.10	19.04	37.58	30.06	13.32	1,692	6.70	1.58
	11.70	11.80	0.10	23.06	19.26	34.96	22.72	3,896	3.05	1.34
	14.90	15.00	0.10	19.19	35.61	30.22	14.98	2,603	8.31	1.55
	15.90	16.00	0.10	17.68	40.26	32.49	9.57	2,142	5.41	1.61
	16.70	16.80	0.10	17.86	38.90	34.28	8.96	2,113	8.03	1.60
	18.15	18.25	0.10	13.48	50.61	24.56	11.35	1,661	5.95	1.75
	19.40	19.50	0.10	15.22	48.29	26.80	9.69	1,711	5.06	1.72
	19.95	20.05	0.10	12.62	45.46	16.35	25.57	981	2.56	1.68
	21.00	21.10	0.10	14.82	48.30	29.40	7.48	1,824	3.14	1.72
	22.40	22.50	0.10	13.73	41.52	33.73	11.02	2,184	4.54	1.63
	39.10	39.20	0.10	15.54	48.34	26.80	9.32	1,854	4.35	1.72
	42.00	42.10	0.10	13.58	54.09	25.02	7.31	1,727	3.85	1.80
	42.90	43.00	0.10	16.50	40.60	31.10	11.80	2,914	4.55	1.62
	46.75	46.85	0.10	15.17	53.51	23.40	7.92	998	4.62	1.79
NG 9/31	54.50	54.60	0.10	21.46	42.79	29.59	6.16	1,998	4.56	1.65
	57.00	57.10	0.10	17.86	58.04	20.37	3.73	1,279	0.90	1.85
	60.10	60.20	0.10	28.42	8.90	33.08	29.60	3,972	1.48	1.20
	60.30	60.40	0.10	18.72	25.73	33.30	22.25	3,417	2.48	1.42
	68.20	68.30	0.10	23.58	43.42	28.40	4.60	1,818	3.30	1.65
	72.35	72.45	0.10	27.74	37.39	26.62	8.25	2,118	3.91	1.58
	77.55	77.65	0.10	21.73	57.74	20.25	0.28	982	3.18	1.84
	83.40	83.50	0.10	19.36	52.10	21.63	6.91	1,734	1.69	1.77
	90.90	91.00	0.10	29.69	21.00	33.16	16.15	3,317	1.50	1.36
	93.95	94.05	0.10	23.54	37.53	32.11	6.82	2,138	6.29	1.58
	97.90	98.00	0.10	25.92	26.53	31.78	15.77	2,763	4.28	1.43
	100.70	100.80	0.10	24.91	29.93	32.16	13.00	2,302	6.09	1.48
	105.90	106.00	0.10	18.88	53.12	21.64	6.36	1,490	1.25	1.78
	113.00	113.10	0.10	24.40	41.49	25.25	8.86	2,008	2.76	1.63
	196.50	196.60	0.10	20.38	57.23	19.33	3.06	1,257	2.11	1.84
	213.40	213.50	0.10	17.75	42.91	26.30	13.04	2,101	3.76	1.65

Table 3-4 Coal Analysis Result (Phase 1)

Lab. No.	Sample Name	Analysis type	From	To	Thickness (m)	S.G. Air dry a.d	Inferent Moisture a.d %	Proximate Analysis (a.r.) Moisture %	Ash %	V. M. %	F. C. %	G.C.V. (a.r.) kcal/kg	T.Sulfur (a.r.) %	Proximate Analysis (a.d.) Moisture %	Ash %	V. M. %	F. C. %	G.C.V. (a.d.) kcal/kg	T.Sulfur (a.d.) %	S.G. dry base	oximate(d. Ash %	G.C.V. (d.b.) kcal/kg
01-CE215	N1-1	Standard	91.85	92.50	0.65	1.79	10.03	31.96	30.63	27.66	9.75	2,354	5.66	10.03	39.23	35.43	15.31	3,015	7.25	1.96	45.02	3,460
01-CE219	N1-2	Csh	96.80	97.56	0.76	2.14	4.54	25.92	49.70	17.65	6.73	1,219	4.10	4.54	63.22	22.45	9.79	1,551	5.21	2.26	67.09	1,646
01-CE221	N1-3S	F-S	98.43	99.15	0.72	1.63	13.45	32.07	19.51	28.18	20.24	3,148	5.27	13.45	23.97	34.63	27.95	3,868	6.48	1.81	28.72	4,634
01-CE216	N1-4	Standard	100.45	100.85	0.40	1.75	10.86	30.68	25.86	26.12	17.34	2,641	5.81	10.86	32.25	32.58	24.31	3,294	7.25	1.93	37.31	3,810
01-CE217	N1-5	Standard	101.73	102.00	0.27	1.77	8.58	32.57	25.90	26.05	15.48	2,564	6.83	8.58	34.07	34.27	23.08	3,373	8.99	1.91	38.41	3,802
01-CE218	N1-6	Standard	103.40	103.87	0.47	1.73	9.53	33.50	25.56	24.34	16.60	2,488	4.23	9.53	33.62	32.01	24.84	3,272	5.56	1.87	38.44	3,741
01-CE220	N1-7	Csh	111.55	112.85	1.30	2.13	5.66	27.67	49.41	16.98	5.94	1,087	3.50	5.66	63.35	21.77	9.22	1,394	4.49	2.28	68.31	1,503
01-CE155	N3-1	Standard	149.75	150.47	0.72	1.91	6.91	25.77	41.68	21.37	11.18	1,759	5.47	6.91	51.37	26.34	15.38	2,168	6.74	2.05	56.15	2,370
01-CE156	N3-2	Standard	151.05	151.60	0.55	1.76	10.02	30.35	28.38	24.85	16.42	2,483	7.13	10.02	35.62	31.19	23.17	3,117	8.95	1.92	40.75	3,565
01-CE157	N3-3	Standard	157.23	157.55	0.32	2.00	7.10	25.56	39.06	22.09	13.29	1,886	8.65	7.10	47.90	27.09	17.91	2,313	10.61	2.17	52.47	2,534
01-CE166	N3-14	Csh	158.00	158.50	0.50	2.18	5.73	20.55	55.47	17.31	6.67	1,054	4.50	5.73	65.12	20.32	8.83	1,237	5.28	2.35	69.82	1,327
01-CE123	N3-4S	F-S	158.50	162.73	4.23	1.91	9.64	24.68	37.25	27.98	10.09	2,199	6.53	9.64	43.84	32.93	13.59	2,588	7.69	2.12	49.46	2,920
01-CE158	N3-5	Standard	164.06	167.55	3.49	1.98	6.55	24.66	45.17	21.71	8.46	1,649	4.58	6.55	55.16	26.51	11.78	2,014	5.59	2.13	59.95	2,189
01-CE167	N3-15	Csh	167.55	168.60	1.05	1.83	9.61	29.60	40.65	20.22	9.53	1,644	4.03	9.61	50.81	25.27	14.31	2,055	5.04	2.01	57.74	2,335
01-CE168	N3-16	Csh	170.40	171.05	0.65	1.70	11.98	33.35	28.79	23.34	14.52	2,294	3.96	11.98	36.61	29.68	21.73	2,917	5.04	1.88	43.20	3,442
01-CE169	N3-17	Csh	171.40	172.00	0.60	1.85	10.04	28.69	38.60	21.72	10.99	1,831	5.22	10.04	47.45	26.70	15.81	2,251	6.42	2.04	54.13	2,568
01-CE139	N3-6S	F-S	172.00	178.55	6.55	1.85	11.53	25.95	37.56	24.72	11.77	2,060	4.49	11.53	43.89	28.89	15.69	2,407	5.25	2.08	50.72	2,782
01-CE159	N3-7	Standard	180.80	181.62	0.82	1.67	11.54	33.68	26.37	26.09	13.86	2,550	3.13	11.54	33.87	33.51	21.08	3,275	4.02	1.83	39.76	3,845
01-CE160	N3-8	Standard	182.30	183.30	1.00	1.69	10.81	30.21	26.86	25.44	17.49	2,655	4.36	10.81	33.33	31.56	24.30	3,294	5.41	1.84	38.49	3,804
01-CE161	N3-9	Standard	185.70	187.60	1.90	1.85	7.80	25.75	39.74	22.47	12.04	2,005	4.17	7.80	48.43	27.39	16.38	2,444	5.08	1.99	53.52	2,700
01-CE162	N3-10	Standard	191.60	191.85	0.25	1.83	8.05	27.21	38.69	21.88	12.22	2,005	4.81	8.05	47.86	27.07	17.02	2,480	5.95	1.97	53.15	2,754
01-CE170	N3-18	Csh	201.24	201.95	0.71	2.08	6.81	21.40	56.34	16.75	5.51	946	3.16	6.81	65.96	19.61	7.62	1,108	3.70	2.26	71.68	1,204
01-CE163	N3-11	Standard	203.60	204.30	0.70	1.84	9.08	30.59	40.05	19.81	9.55	1,635	5.82	9.08	51.03	25.24	14.65	2,083	7.41	2.01	57.70	2,356
01-CE164	N3-12	Standard	209.80	210.15	0.35	1.90	7.61	22.92	47.79	20.09	9.20	1,558	4.15	7.61	56.43	23.72	12.24	1,840	4.90	2.05	62.00	2,021
01-CE165	N3-13	Standard	211.10	214.17	3.07	1.66	9.45	24.56	37.93	35.70	1.81	2,292	4.40	9.45	44.68	42.05	3.82	2,700	5.18	1.78	50.28	3,038
01-CE171	N5-1S	F-S	93.20	95.40	2.20	1.73	11.12	31.43	23.64	26.24	18.69	2,765	1.69	11.12	29.66	32.93	26.29	3,470	2.12	1.90	34.48	4,032
01-CE209	N5-2	Csh	95.40	96.50	1.10	1.89	9.25	27.74	47.19	17.83	7.24	1,207	2.90	9.25	57.89	21.87	10.99	1,481	3.56	2.08	65.31	1,670
01-CE203	N5-3	Standard	98.35	101.20	2.85	1.79	10.16	29.46	42.04	19.37	9.13	1,530	2.74	10.16	52.09	24.00	13.75	1,896	3.40	1.97	59.60	2,169
01-CE210	N5-4	Csh	101.20	102.50	1.30	1.82	8.74	29.08	46.19	17.62	7.11	1,214	1.88	8.74	57.98	22.12	11.16	1,524	2.36	1.98	65.13	1,712
01-CE204	N5-5	Standard	104.18	104.70	0.52	1.68	10.88	34.34	30.11	21.96	13.59	2,137	2.67	10.88	39.34	28.69	21.09	2,792	3.49	1.83	45.86	3,255
01-CE205	N5-6	Standard	105.35	106.55	1.20	1.68	9.66	31.79	34.82	24.43	8.96	2,003	3.27	9.66	44.72	31.37	14.25	2,572	4.20	1.81	51.05	2,937
01-CE211	N5-7	Csh	108.15	109.00	0.85	1.80	9.21	28.84	42.70	19.72	8.74	1,532	3.65	9.21	53.13	24.54	13.12	1,906	4.54	1.96	60.01	2,153
01-CE206	N5-8	Standard	110.75	111.25	0.50	1.64	12.86	33.65	25.12	24.87	16.36	2,524	4.24	12.86	31.71	31.40	24.03	3,186	5.35	1.81	37.86	3,804
01-CE212	N5-9	Csh	149.60	150.20	0.60	2.01	6.72	28.15	53.77	14.32	3.76	703	2.67	6.72	68.44	18.23	6.61	895	3.40	2.17	74.84	978
01-CE213	N5-10	Csh	151.39	152.05	0.66	1.84	7.69	28.77	42.92	17.91	10.40	1,164	2.57	7.69	54.38	22.69	15.24	1,475	3.26	1.98	60.26	1,634
01-CE214	N5-11	Csh	160.45	161.20	0.75	2.08	6.68	24.83	57.25	15.04	2.88	664	4.04	6.68	69.95	18.38	4.99	811	4.94	2.25	76.16	883
01-CE207	N5-12	Standard	163.20	163.57	0.37	1.85	8.49	27.83	44.48	18.46	9.23	1,472	4.50	8.49	55.15	22.89	13.47	1,825	5.58	2.01	61.63	2,040
01-CE187	N5-13S	F-S	164.85	166.95	2.10	1.79	8.81	30.73	31.84	24.33	13.10	2,285	4.48	8.81	40.78	31.16	19.25	2,926	5.74	1.94	45.97	3,299
01-CE208	N5-14	Standard	168.30	169.10	0.80	1.65	10.52	33.45	31.35	22.66	12.54	2,173	3.73	10.52	40.68	29.40	19.40	2,820	4.84	1.79	47.11	3,265
01-CE107	P3S	F-S	5.60	8.82	3.22	1.76		35.39	25.47	24.83	14.31	3,327	6.23	0.00	39.42	38.43	22.15	5,149	9.64	1.76	39.42	5,149

Lab. No.	Sample Name	Ultimate Analysis (d.a.f.) C %	H %	N %	TS %	O+loss %	HGI	Moist,Mm -freeBtu	Coal Rank (ASTM)	Ash Composition (dry) SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	MgO (%)	K_2O (%)	Na_2O (%)	SO_3 (%)	TiO_2 (%)	Mn_3O_4 (%)	Form of Sulpur (d.b.) T.S %	Sul S (%)	Pyr S (%)	Org S (%)
01-CE215	N1-1	72.34	3.92	2.89	15.12	5.72	93	6,197	ligB														
01-CE219	N1-2							4,514	ligB														
01-CE221	N1-3S	66.30	4.47	1.78	10.28	27.44	51	7,106	ligA	28.45	18.97	25.21	9.01	3.45	1.99	1.94	7.88	0.52	0.04	7.33	0.10	3.57	3.65
01-CE216	N1-4	69.46	4.13	1.86	13.37	11.18	58	6,480	ligA														
01-CE217	N1-5	70.18	4.10	1.94	16.45	7.34	66	6,260	ligB														
01-CE218	N1-6	68.94	4.63	1.80	10.33	14.31	63	6,090	ligB														
01-CE220	N1-7							3,985	ligB														
01-CE155	N3-1	66.61	10.61	1.67	16.81	4.31	96	5,565	ligB														
01-CE156	N3-2	71.13	8.10	1.71	17.28	1.78	65	6,286	ligB														
01-CE157	N3-3	64.35	9.76	1.43	24.46	0.00	>100	5,583	ligB														
01-CE166	N3-14							4,445	ligB														
01-CE123	N3-4S	69.45	5.23	1.69	14.30	9.33	70	6,465	ligA	34.20	19.27	16.39	12.82	1.59	1.70	1.17	11.67	0.52	0.08	8.67	0.40	3.92	4.35
01-CE158	N3-5	66.76	5.50	1.58	15.17	10.98	99	5,625	ligB														
01-CE167	N3-15							5,118	ligB														
01-CE168	N3-16							5,891	ligB														
01-CE169	N3-17							5,474	ligB														
01-CE139	N3-6S	66.00	4.06	1.77	???	???		6,115	ligB	40.97	23.05	12.55	9.06	1.88	2.21	1.21	5.21	0.63	0.05	6.07	0.41	2.40	3.27
01-CE159	N3-7	70.44	5.61	2.08	7.84	14.02	62	6,352	ligA														
01-CE160	N3-8	69.72	5.34	1.88	10.15	12.91	67	6,649	ligA														
01-CE161	N3-9	68.33	6.16	2.29	12.09	11.13	88	6,207	ligB														
01-CE162	N3-10	68.08	6.43	1.86	14.12	9.52	83	6,062	ligB														
01-CE170	N3-18							4,129	ligB														
01-CE163	N3-11	65.63	4.66	1.59	19.85	8.27	88	4,953	ligB														
01-CE164	N3-12	61.63	7.69	1.25	14.16	15.27	97	5,633	ligB														
01-CE165	N3-13	67.04	7.66	1.33	11.73	12.24	77	6,898	ligA														
01-CE171	N5-1S	62.43	4.48	1.92	3.76	27.40	46	6,653	ligA	37.44	22.14	18.85	7.08	4.76	2.26	1.24	4.86	0.67	0.03	2.46	0.12	0.74	1.60
01-CE209	N5-2							4,274	ligB														
01-CE203	N5-3	61.93	1.35	1.79	9.61	25.32	66	4,929	ligB														
01-CE210	N5-4							4,261	ligB														
01-CE204	N5-5	44.97	0.99	1.82	7.52	44.68	62	5,625	ligB														
01-CE205	N5-6	54.36	1.11	1.81	9.79	32.93	72	5,680	ligB														
01-CE211	N5-7							4,964	ligB														
01-CE206	N5-8	68.40	3.43	1.63	10.29	16.25	47	6,140	ligB														
01-CE212	N5-9							2,798	ligB														
01-CE213	N5-10							3,765	ligB														
01-CE214	N5-11							2,763	ligB														
01-CE207	N5-12	62.89	3.30	1.37	16.23	16.21	95	4,900	ligB														
01-CE187	N5-13S	68.16	4.83	1.36	11.97	13.68	72	6,158	ligB	41.62	26.02	11.60	7.01	2.72	2.88	0.83	4.78	0.88	0.04	6.47	0.26	1.97	4.23
01-CE208	N5-14	67.67	4.02	1.56	10.59	16.17	81	5,812	ligB														
01-CE107	P3S	67.37	4.47	1.75	11.47	14.95	62	8,220	ligA	38.55	23.94	13.87	9.61	2.03	2.28	0.20	7.37	0.63	0.06	6.95	0.71	1.91	4.33

Table 3-5 Proximate analysis of Zone Ⅰ and Zone Ⅱ

(ar base)

Zone Ⅰ	Moisture (%)	Ash (%)	V.M. (%)	F.C. (%)	H.V. (kcal/kg)	S (%)
NG 3/40	22.90	38.05	32.17	6.88	1,814	6.90
NG 5/40	24.65	34.08	29.02	12.25	2,140	4.03
NG 10/40	20.49	34.03	32.95	12.53	2,506	7.23
NG 12/40	18.10	42.93	27.21	11.76	2,175	4.00
NG 16/40	27.80	30.10	29.96	12.14	2,300	5.96
NGG 1/40	26.83	26.12	31.86	15.19	2,467	5.67
NGG 2/40	26.17	28.64	32.99	12.20	2,158	7.48
NGG 3/40	27.20	29.41	29.95	13.44	2,435	3.99
NGG 4/40	24.91	28.19	32.63	14.27	2,656	5.81
LN1/21	33.75	11.36	25.16	11.36	2,090	2.46
LN3/21	39.44	25.32	25.33	10.06	2,088	1.92
LN11/21	30.19	30.20	26.71	12.87	2,108	3.16
LN26/21	32.84	29.13	27.74	10.28	2,134	2.16
LN27/21	19.92	52.64	20.57	6.87	1,243	3.46
LN28/21	33.69	25.52	27.88	12.92	2,495	2.77
NG3/31	12.45	51.35	26.51	9.69	1,968	3.86
NG7/31	17.52	38.64	30.79	13.06	2,225	5.63
NG9/31	22.89	39.78	27.46	9.88	2,157	3.12
NGJ1/43	31.82	25.32	27.31	15.54	2,705	5.72
NGJ3/43	26.21	37.89	24.54	11.37	2,058	5.02
NGJ5/43	31.04	33.41	22.79	12.77	2,085	2.60
Average	**26.23**	**32.96**	**28.17**	**11.78**	**2,191**	**4.43**

Zone Ⅱ	Moisture (%)	Ash (%)	V.M. (%)	F.C. (%)	H.V. (kcal/kg)	S (%)
NG 5/40	21.32	40.31	28.57	9.80	2,114	4.03
NGG 1/40	24.30	29.92	31.69	14.09	2,505	4.36
NGG 2/40	25.42	30.37	33.39	10.82	2,549	6.19
NGG 3/40	22.99	31.25	32.45	13.31	2,659	4.90
NGG 4/40	19.50	36.92	31.90	11.68	2,214	6.18
LN26/21	31.72	25.30	30.46	12.52	2,470	3.51
NG 3/31	14.54	42.09	29.16	14.21	2,585	4.13
NG 7/31	15.16	49.36	26.46	9.02	1,848	4.34
NG 9/31	17.75	42.91	26.30	13.04	2,101	3.76
NGJ3/43	24.37	39.07	33.90	2.66	2,207	4.37
NGJ5/43	31.44	31.71	23.90	12.95	2,256	4.29
Average	**22.59**	**36.29**	**29.83**	**11.28**	**2,319**	**4.55**

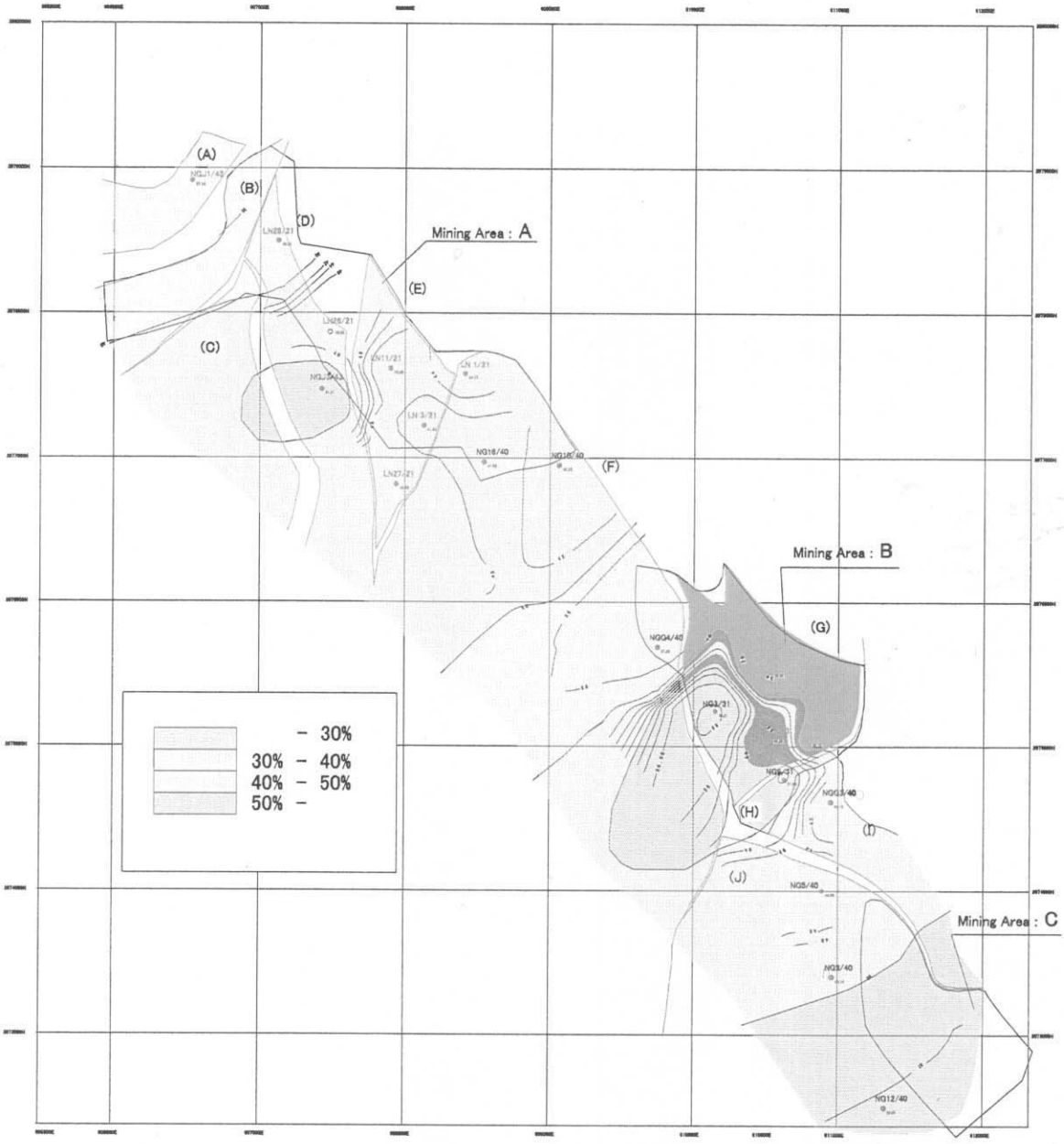


Figure3-3 Iso-value Contour Map on Ash Content(% , dry)

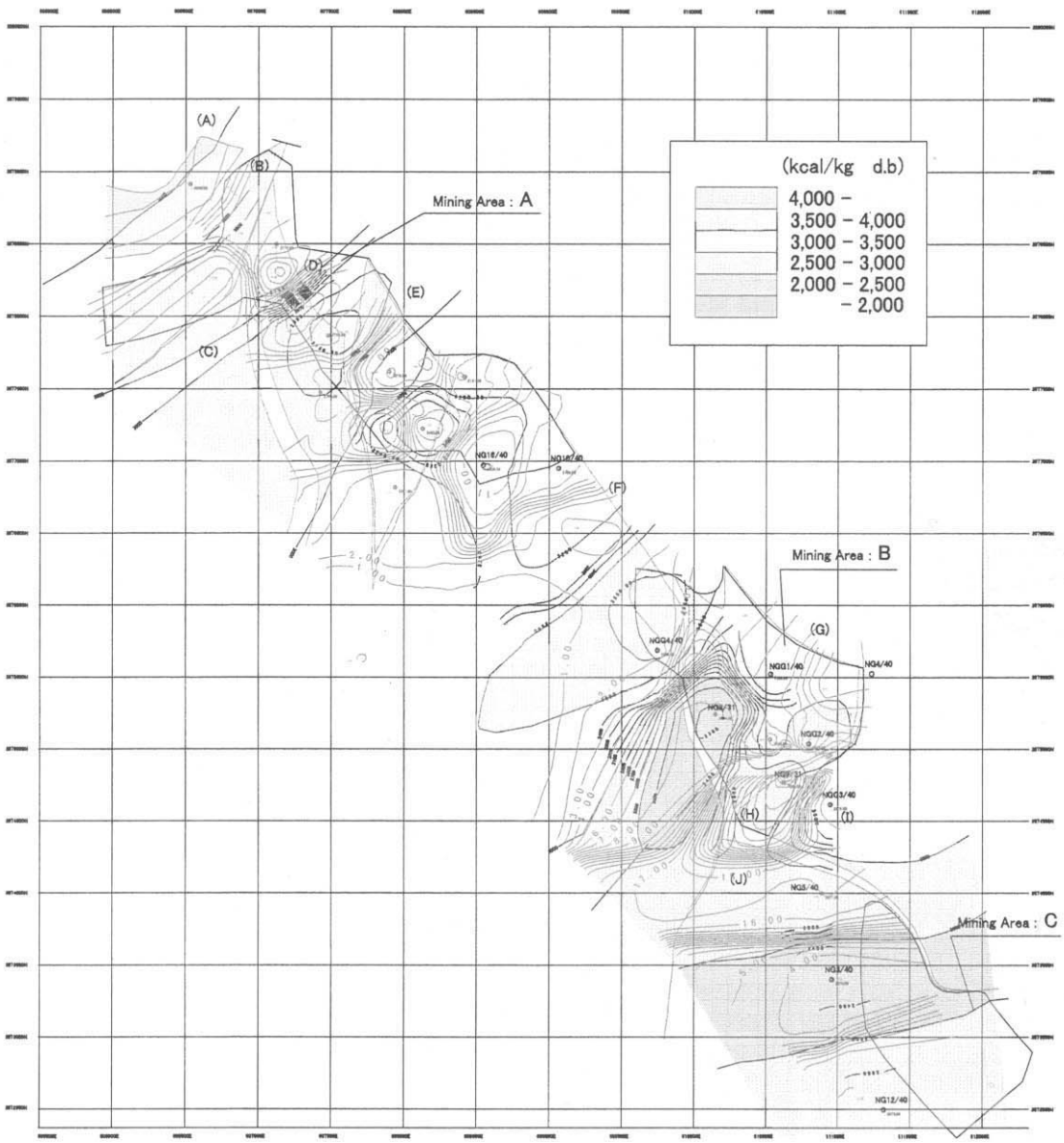


Figure3-4 Iso-value Contour Map on Heating Value(kcal/kg , dry)

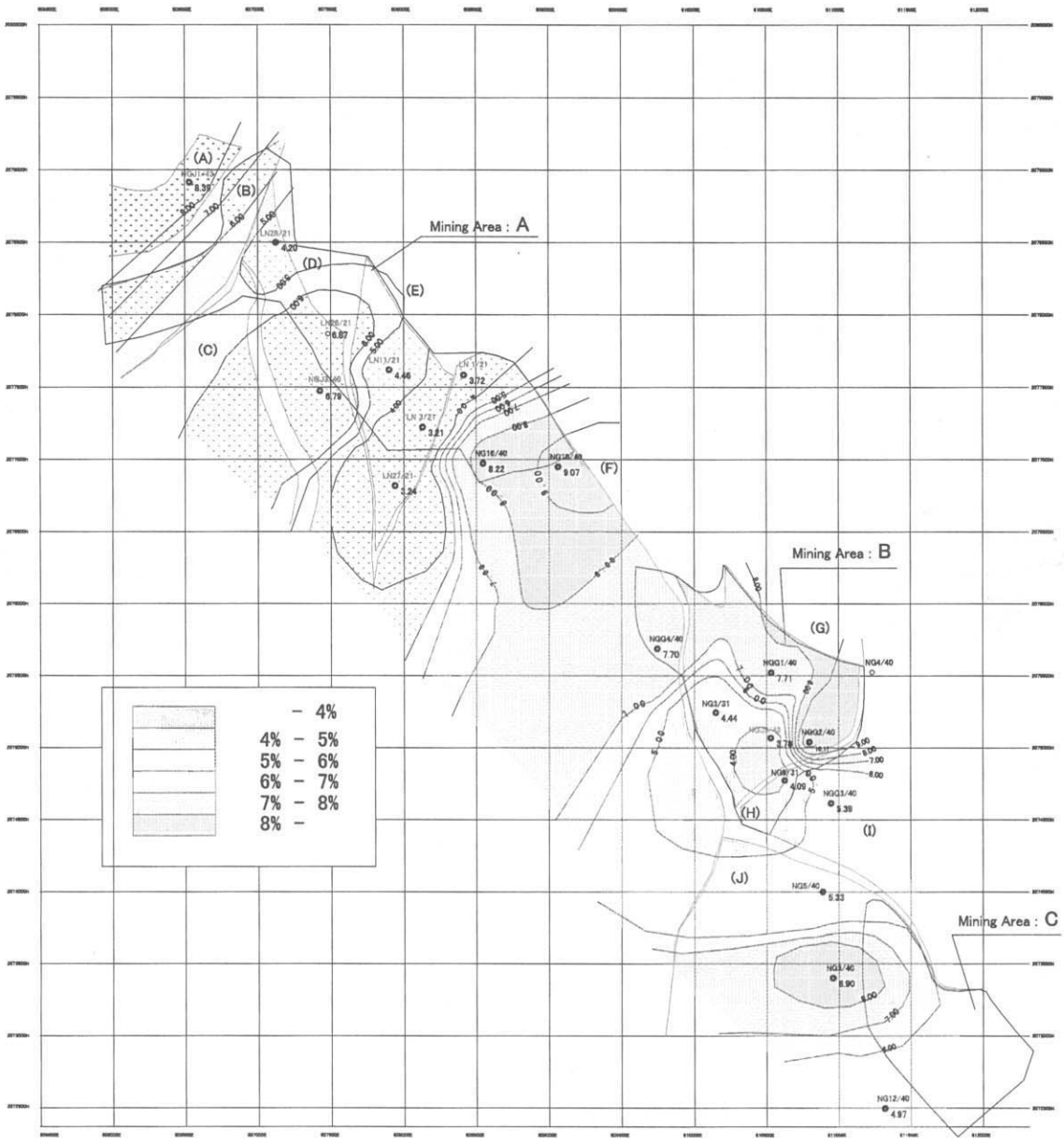


Figure3-5 Iso-Value Contour Map on Total Sulphur Content(% , dry)

3.3.1 Moisture

The moisture content on as received basis (total moisture) is 20% to 34% and its average is 30%. The moisture content on air-dried basis (inherent moisture) is reported about 20%, two thirds of the total moisture. This means that one thirds of the total moisture of Ngao coal is surface moisture. Removing surface moisture is one of the effective quality upgrade technologies.

3.3.2 Ash

According to the iso-value contour map of ash on dry basis (Figure 3-3), the weighed average of ash content in the whole Ngao area is calculated as 44.8%. This is converted into 31.4% on as received basis and 35.4% on air-dried basis.

High ash value is due to the presence of many non-coal partings (shale to carbonaceous shale) in the sampling section. The bulk sample section for quality upgrading is without any visible partings as shown in Figure 2-3, however its ash content on air-dried basis is 21%. It is probably due to invisible mineral matter (Al_2O_3, Fe_2O_3, etc)

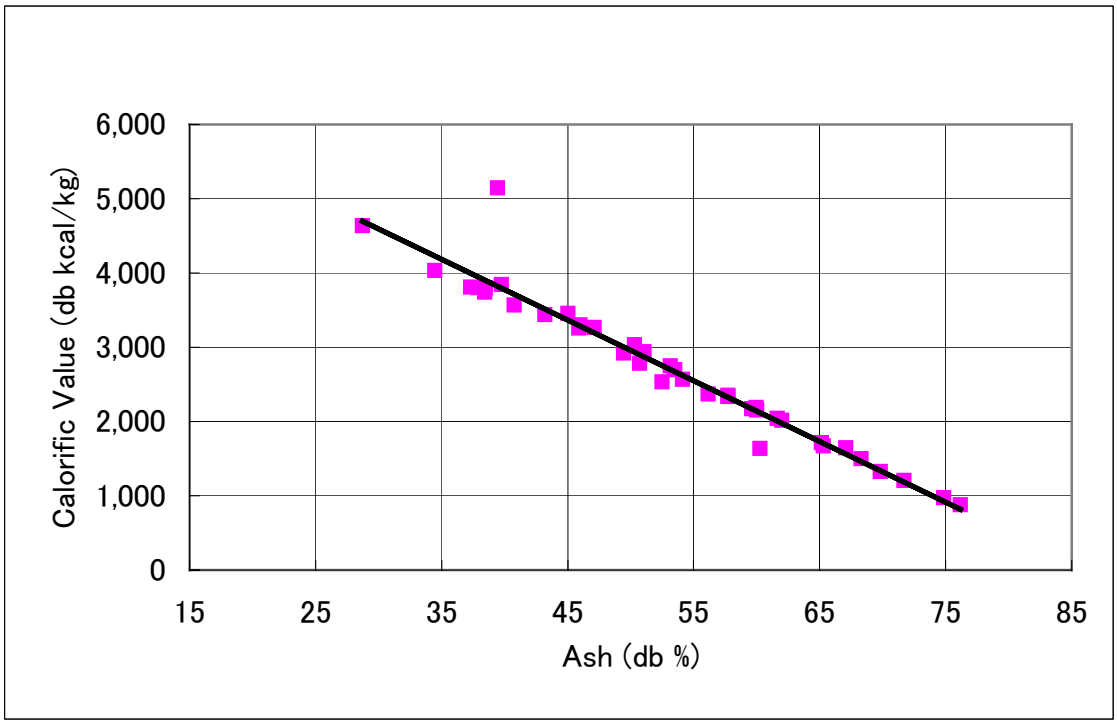
3.3.3 Volatile Matter

The average volatile matter content is about 28% on as received basis. It is converted into 38% on dry basis. Fuel ratio, which is given by dividing fixed carbon by volatile matter, is 0.44 in a similar range of that in the Lampang coalmine

3.3.4 Calorific Value

According to the iso-value contour map of calorific value on dry basis (Figure 3-4), the weighed average of calorific value in the whole Ngao area is calculated as 3,039 kcal/kg. This is converted into 2,127 kcal/kg on as received basis. Low calorific value is the effect of higher content of ash. Calorific value is usually proportional to ash content. Figure 3-6 illustrates the relationship between calorific and ash content of the coal analysis results in this exploration.

Figure 3-6 Calorific Value vs Ash Relationship



3.3.5 Total Sulfur

Figure 3-5 shows the iso-value contour map on total sulfur contents on dry basis. The weighed average of total sulfur in the whole Ngao area is 6.24 %. Total sulfur in the proposed mining Area-A tends to be rather low. Zone I in NGJ5/45 shows the sulphur content as low as about 2%. More quality data are required through drilling

in the future and then areas having low sulphur content will be selected for development.

The results of analysis done in this exploration have been given the average form of sulfur in Ngao area as follows,

Sulphide (Pyrite)	2.37%	(38%)
Sulphate	0.31%	(5%)
Organic	3.56%	(57%)
Total	6.24%	(100%)

This means that a half of sulphur in Ngao presumes organic sulfur combined with hydrocarbon in texture of coal. It is confirmed that sulphide in Ngao coal exists equally as small particles as 0.01 to 0.02 mm in diameter, while large crystal pyrite as a common form of sulphide in high sulfur coal deposited under transgressional condition was not seen.

Very fine-grained pyrite in Phrae coal was explained in a JICA–DMR report in 1997, that this type of sulphide form is presumes to be a characteristics of Thai coal deposited in intermountain lacustrine basins.

3.3.6 Ultimate Analysis

In general, carbon content increases as degree of coalification becomes higher, while oxygen content changes in the opposite way. From this point of view, it is supposed that degree of coalification may be higher in the northern part than in the southern part. The degree of coalification in Ngao is same as one in Mae Moh.

3.3.7 Hardgrove Grindability Index (HGI)

HGI is reported to be 46 to over 100 and generally high enough for quality requirement of steaming coal (>40-45).

3.3.8 Analysis of Ash

Composition of ash are analyzed for the purpose of predicting the effect of ash during combustion in a cement kiln, particularly estimation of the combination ratio of coal and other cement raw materials. CaO, other alkaline and SO_3 are slightly high, however those do not effect on the cement kiln and are suited for cement industry.

According to the analysis result this year, the suitability indexes such as Fouling and Slugging for electric power plant were predicted. By Japanese standard on bituminous coal most of the results are over the quality requirement for combustion and then this coal is not suitable for boiler in electric power plants.

3.3.9 Coal Rank

The analytical result indicates that most coals in the study area are classified as Lignite A (ligA) or Lignite B (ligB) in coal rank according to the ASTM standard. Some of coals are ranked to subbituminous B to C (subB to subC).

4. Tests for Coal Preparation and Upgrading

4.1. Test for Coal Preparation

4.1.1. Screening and Float and Sink Test

As mentioned in the previous section, screening test and float and sink test were conducted on bulk sample and drill core sample, for the purpose of evaluating washability by conventional coal preparation method. Test result of bulk sample is illustrated in Christopher diagram of Figure 4-1.

The Christopher diagrams of core samples are shown in Appendix-7.

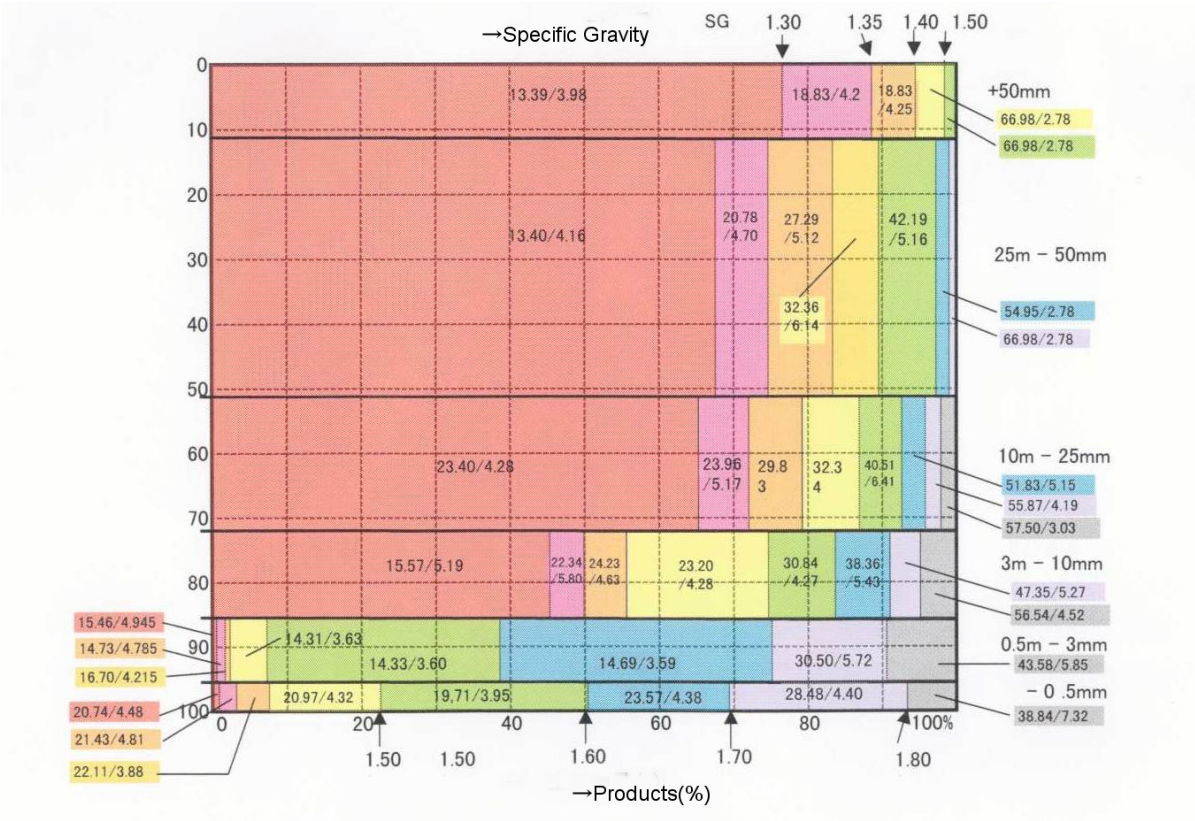


Figure 4-1 Christopher Diagram