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Coal resources in the Indian Gondwana

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THE per capita consumption of energy is a true index of a nation's wealth and progress. This can be judged by the fact that the overall energy consumption of about eight terrawatt (1 terrawatt = 10^{12} watt) is concentrated mainly with the developed countries while in the developing countries the consumption is of the order of 2 terrawatt (1984). The most significant commercial sources of energy are coal, oil and electricity while non-commercial fuels are fire wood, agricultural waste and animal dung. Our country is endowed with practically every form of energy source in small or large measures. Coal occupies the leading place in so far as the availability of resources are concerned. The share of coal in the total commercial energy consumption/production (1984-85) of our country is of the order of about 59 per cent.

COAL OCCURRENCES

The workable coal deposits in India occur only in two stratigraphic horizons, viz., the Permian Gondwana and the Tertiary (Eocene and Oligocene). The Gondwana coals are largely confined to peninsular India and constitute about 99.5 per cent of the total coal resources of the country. The Gondwana coal deposits are restricted in the south eastern quadrant bounded by 78°E longitude and 24°N latitude leaving major part of the country devoid of any workable coal occurrences (Map 1). Some minor deposits of Gondwana coal with complicated geo-mining conditions also occur in foot-hills of the Himalaya in West Bengal, Assam, Arunachal Pradesh and Sikkim.

The Gondwana coalfields are generally aligned along prominent river valleys, viz., Damodar-Koel, Son-Mahanadi, Pranhita-Godavari and Satpura area. The Rajmahal Hill coalfields aligned N-S are located north-east of Damodar Valley. All the Gondwana coalfields excepting that in the Godavari Valley fall within the command area of the Coal India Limited. The major coalfields in which mining is going on within the command area of the various coal companies are as follows:

Eastern Coalfields Ltd.—Raniganj, Rajmahal and Saharjuri coalfields.

Bharat Coking Coal Ltd.—Jharia and North-Western part of Raniganj Coalfields.

Central Coalfields Ltd.—East Bokaro, West Bokaro, Ramgarh, North Karanpura, South Karanpura, Daltonganj, Hutar, Giridih and Jainti coalfields.

Western Coalfields Ltd.—Umrer, Kamptee, Chanda-Wardha, Pench-Kanhan and Pathakhera coalfields.

Southeastern Coalfields Ltd.—Umaria, Johilla, Sohagpur, Jhagrakhand, Sonhat, Jhilimili, Chirimiri, Bisrampur, Korba, Mand-Raigarh, Ib-Valley and Talcher coalfields.

Northern Coalfields Ltd.—Singrauli Coalfield.

The Gondwana coalfields occupy a total area of 63,605 sq km, only 1.9 per cent of the total area of the country. This, however, is not the true index of the coal-bearing potential of the coalfields involved. Sizeable areas are covered by non-coal-bearing formation excluding which the coal-bearing area represents only about 14,000 sq km. This coal-bearing area represents only about 0.5 per cent of the total area of the country.

GEOLOGICAL SET UP

The prominent coal-bearing formations in the Gondwana are the Karharbari (Basal Coal Measures) and the Barakar (Lower Coal-Measures), which account for the bulk of the resources available in the country. The Raniganj Formation (Upper Coal-

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Measures) is well-developed in the Raniganj Coalfield and contains the bulk of the superior grade non-coking coals as well as blendable coals.

The distribution of coal in the various stratigraphic horizons within Gondwana is as follows:

Age	*Geological Formation*	*Occurrence*
Lower Cretaceous	Umia and Jabalpur formations	Thin coal seams in Gujarat
Lower Jurassic	Kota and Chikiala formations	Thin coal seams in Satpura and Godavari
Upper Permian	Raniganj Formation and equivalents	Peninsular India and Himalayan foot-hills
Middle Permian Lower Permian	Barren Measures Barakar & Karharbari formations	

The individual Gondwana coal basins usually represent a "half graben" configuration with one side delineated by a pronounced boundary fault running generally parallel to the structural trend of the surrounding Precambrian rocks. The other margin of the basin shows unfaulted sedimentary contact though punctuated by many cross faults. Intrabasinal faults occur in all the coalfields having wide variation in magnitude.

Basic (dolerite) and ultrabasic (lamprophyre and periodotite) intrusives occur in varying amounts in different basins and are generally correlated to the Rajmahal (Early Cretaceous) and the Deccan (Late Cretaceous to Early Eocene) volcanic activities. The lamprophyre and other alkaline igneous rocks occurring mostly in the Damodar Valley coalfields have extensively damaged the coal deposits in these coalfields.

COAL CHARACTERISTICS

The Gondwana coals are sub-bituminous to bituminous in rank and usually contain high ash. Even the best quality seams rarely have less than 15 per cent ash. This is primarily due to the very nature of the environment in which the coals accumulated. Because of the inherent high ash content, the average heat value is around 5,000 KCal/kg.

The moisture content of Barakar coal in the eastern and central Damodar Valley is generally low, while in other areas it is as high as 6 to 10 per cent. Moisture is also invariably on higher side in Raniganj coals, except in a few seams in the western part of the Raniganj Coalfield. The volatile matter ranges from low to medium in the Barakar coals of Damodar Valley and medium to high in other areas. The coals from the Raniganj Formation are also high in volatile content. The sulphur content is generally low rarely exceeding 0.6 per cent, in Gondwana coals (Table 1). The average reflectance in oil generally varies between 0.5 and 1 (Table 2).

In general, the Gondwana contain moderately thick to very thick coal seams. In some of the coalfields like Raniganj, Rajmahal, East and West Bokaro, North and South Karanpura, Korba, Singrauli, Ib-River and Talcher 20 to 40 m thick coal seams occur in the Lower Barakar Formation. These thick seams, however, contain numerous dirt bands rendering the quality of coal inferior.

The coalfields of Damodar Valley are relatively deeper basins (1,200 to 1,500 m) and contain a number of coal seams (12 to 15) while those of the other coalfields the basin depth mostly restrict to 600 m with on an average 4 to 5 coal seams within it.

COAL RESOURCES

Based on the available information, through geological mapping, regional drilling and detailed exploration, the total coal resources in India has been assessed in April, 1986 by a Sub-group on coal exploration formed at the instance of the Working Group constituted by the Planning Commission in connection with the development of an Energy Model. This Sub-group on Coal Exploration represented by CMPDI, GSI and MECL has estimated the total coal resources in Indian Gondwana at 157,624 million tonnes spread over in 45 coalfields. These resources are available in seams of 0.5 m and above in thickness and up to 1,200 m depth. The break up of the resources under different categories, types and depth cut-offs are given below:

Depth	*Type*	*Resource in million tonnes*			
		Proved	*Indicated*	*Inferred*	*Total*
Up to 300 m	Prime Coking	2166	155	2	2323
	Medium Coking	6082	4334	394	10810
	Blendable	607	330	26	963
	Non-Coking	29238	38197	19396	86831
	Total	38093	43016	19818	100927
300-600 m	Prime Coking	1369	759	287	2415
	Medium Coking	2448	3280	412	6140

	Blendable	154	723	103	980
	Non-Coking	3210	12778	15688	31676
	Total	7181	17540	16490	41211
600-1200 m	Prime Coking	88	644	—	732
	Medium Coking	707	1898	28	2633
	Blendable	77	245	561	883
	Non-Coking	158	2594	8486	11238
	Total	1030	5381	9075	15486
Up to 1200 m	Prime Coking	3623	1558	289	5470
	Medium Coking	9237	9512	834	19583
	Blendable	838	1298	690	2826
	Non-Coking	32606	53569	43570	129745
	Total	46304	65937	45383	157624

It may be seen from the above Table that 64 per cent of the coal resources of the Gondwana basins is available within 300 m depth range, while 26 per cent is confined to 300 to 600 m depth and the balance 10 per cent occurring at depth more than 600 m. Further, of the total reserves, only 30 per cent fall under the "proved" category.

The state-wise and grade-wise (for proved reserve only) distribution of the coal inventory is given in Table 3. Quality-wise, coking coal resources (prime, medium and blendable) amount to only 18 per cent of the total coal resources and are confined almost entirely to the Damodar Valley coalfields. This region also contains bulk of the superior grade non-coking coal resources which amount to only 26 per cent (up to 25% ash) of the total coal resources of the Gondwana. In general, there is an acute shortage of direct feed coking coal and low ash (less than 19%) non-coking coal. These two types together constitute about 6 per cent of the total resources of the Gondwana.

COAL DEMAND PROJECTIONS AND EXPLORATION PREPAREDNESS

The post-nationalisation period has seen the country's coal production increase from about 77 million tonnes in 1972-73 to 166 million tonnes in 1986-87. The Planning Commission in its VII Plan documents have envisaged a coal demand of 237 million tonnes by 1989-90, 326 million tonnes in 1994-95 and 417 million tonnes by the turn of the century. Of the above demand projection of total India, only about 2 to 3 million tonnes in different plan periods is expected to come from Tertiary coalfields. Further, the Coal India's share would be about 88 per cent of the total demand in different terminal years.

In order to meet the ever increasing demand of coal, as indicated above, long-term perspective plans are the essential feature and detailed coal exploration being the first input. On this back-ground, CMPDI drew up a long term exploration programme which envisaged a total drilling of 2.77 million metres within a period of 8 years beginning from 1982-83 and ending in 1989-90 to meet the demand of coal by 1999-2000. For executing this programme, it was envisaged to deploy on an average 200 drills of various exploration agencies. Conventional methods of exploration have been supplemented by modern techniques, viz., photogeology/remote sensing, non-coring drilling, drill hole survey, surface and bore hole geophysical survey, hydrogeological and geo-engineering investigations, geo-statistical studies and computer applications.

As a result of the above indicated concerted efforts, CMPDI has almost completed the detailed exploration in respect of all the mining blocks programmed for production up to 2000 AD excepting only in 27 blocks where detailed exploration is either in progress or is about to be taken up shortly. In any case, the exploration requirement for 2000 AD would be met well before 1989-90 thereby providing a lead time of about 10 years for mine development. Additionally, a large number of blocks (21) have been proved and kept in shelf for meeting any spurt in demand. Additionally, drilling is also in progress in 30 blocks which have not been identified for production up to 2000 AD.

DETAILED EXPLORATION COVERAGE AND FUTURE STRATEGY

An overview of the status of detailed coal exploration would indicate that of the total 14,000 sq km coal-bearing area in Gondwana basins, a considerable area has already been covered by detailed exploration. This detailed coal exploration has so far been restricted mostly to the developed areas where infrastructural facilities were generally available. As it stands today, the coverage of detailed exploration in different major coalfields can be broadly grouped under the following four heads:

(i) Coalfields where detailed exploration largely (above 90%) completed:

1. Barjora (20 sq km)
2. Deoghar (25 sq km)
3. Jharia (400 sq km)
4. West Bokaro (120 sq km)
5. Ramgarh (50 sq km)
6. South Karanpura (80 sq km)
7. Daltonganj (44 sq km)
8. Umrer (4 sq km)

Table 1—Chemical properties of coal from different coalfields of India

Coalfields	*Seams*	Analyses on air-dried basis				*Analyses on dry mineral free basis*				*Gray King (L.T.C.) coke type*
		Moisture %	*Ash* %	*Sulphur* %	*Phospho-rous* %	*Volatile matter* %	*Calorific value* (Kcal/kg)	*Carbon* %	*Hydrogen* %	
1	2	3	4	5	6	7	8	9	10	11
				(A) LOWER GONDWANA COALS						
Damodar-Koel Valley										
1. Raniganj										
(a) Raniganj Formation	Dishergarh, Sanotoria, etc.	2.5-3.5	15-20	0.5-0.7	0.01-0.15	39-44	8110-8450	83-85	5.3-5.8	E-G1
	Samla-Jambad, etc.	3.0-11.0	13-25	0.5-0.7	0.01-0.15	39-42	7610-8170	79-82	5.2-5.5	A-B
(b) Barakar Formation	Laikdih-Chanch, etc.	0.8-2.0	15-25	0.5-0.7	0.01-0.20	25-36	8440-8830	86-90	4.5-5.4	E-G
	Salanpur, etc.	0.8-2.0	23-35	0.5-0.8	0.01-0.18	25.35	8300-8800	87-90	4.5-5.2	B-D
2. Barjora	I-IX	3.0-8.0	26-36	0.4-0.9	0.01-0.36	37-43	7810-8060	81-84	4.8-5.7	A
3. Jharia										
(a) Raniganj Formation	Mohuda, Lohpiti, etc.	1.5-2.2	20-25	0.5-0.7	0.20-0.40	36-40	8440-8550	85-87	5.4-5.8	E-F
(b) Barakar Formation	I-VIII	0.6-1.5	18-35	0.5-0.8	0.05-0.30	17-28	8550-8890	90-93	4.5-4.9	C-F
	IX-XVIII	0.6-2.0	15-25	0.5-0.7	0.05-0.30	22-35	8440-8890	87-91	4.6-5.4	G-G8
4. East Bokaro, Barakar Formation	Jarangdih to Uchitdih	0.8-2.4	15-27	0.5-0.9	0.05-0.40	28-36	8330-8670	85-90	4.5-5.4	D-G2
	Kargali top, Karo Bottom	0.7-1.9	17-28	0.5-0.7	0.06-0.17	24-37	8440-8780	86-90	4.5-5.4	E-G4
5. West Bokaro, Barakar Formation	Kuju, Murpa, etc.	4.2-4.7	15-22	0.5-0.7	0.10-0.35	34-37	8170-8370	84-86	4.9-5.1	C-D
	V-VIII	0.5-2.5	21-35	0.5-0.6	0.03-0.35	21-36	8440-8780	86-91	4.6-5.3	D-G3
6. Ramgarh (Block-I, II, IV) Barakar Formation	VI-VIIIA	0.5-3.0	18-30	0.6-1.0	0.01-0.25	24-38	8220-8780	85-87	4.5-5.3	E-G
7. North Karanpura, Barakar Formation										
(a) Chano-Rikba, Badam-Isko, etc.	I-VI	0.5-3.0	20-35	0.5-1.0	0.06-0.34	30-40	8330-8780	85-91	4.9-5.3	E-G3
(b) Bachra, Churi, Manki, Pinderkom, etc.	I-VI	5-10	15-30	0.2-0.8	0.01-0.23	35-42	7400-8000	79-82	4.0-4.9	A-C
8. South Karanpura, Barakar Formation	Krgoda group Sirka, Saunda, Nakaria, etc.	2.5-8.0	15-30	0.4-0.8	0.03-0.2	37-40	78008-8100	80-84	4.7-5.2	A-C
9. Hutar, Karharbari Formation	II	6-10	8-14	0.3-0.5	0.005-0.01	35-40	7500-7700	80-81	4.2-4.5	A
10. Daltonganj, Karharbari Formation	Rajhara 'A'	3-4	13-18	0.4-0.7	0.005-0.01	9-13	8500-8560	89-93	3.5-4.0	A
Giridih—Rajmahal Area										
1. Giridih										

(*Contd.*)

Table 1—*Contd.*

(a) Karharbari Formation	Upper and Lower Karharbari Bhadua	0.6-1.3	12.22	0.4-0.6	0.01-0.04	27-33	8725-0950	89-91	4.7-5.2	E-G6
(b) Barakar Formation	Khandiha, Balihill, etc.	0.7-1.3	20-34	0.3-0.4	0.02-0.16	27-33	0000-8850	88-90	4.6-5.1	D-E
2. Deogarh, Barakar Formation	I-III	5-9	15-35	0.3-0.5	0.002-0.04	38-42	7300-7900	80-83	4.5-5.2	A
3. Rajmahal, Barakar Formation	I-XII	8-10	20-45	0.3-9.7	0.005-0.01	38-40	7400-7800	78-81	4.0-5.2	A
4. Darjeeling, Barakar Formation	—	1-5	19-23	—	—	14-18	8450-8700	90-93	3.5-4.0	A
Son-Mahanadi Valley										
1. Singrauli										
(a) Raniganj Formation	Jhingurda	8-9	25-35	0.4-06	0.01-0.04	40-42	7095-7300	76-78	4.5-4.8	A
(b) Barakar Formation	Turra, Purewa, etc.	7-9	15-30	0.5-0.7	0.02-0.03	37-45	7640-7750	78-81	4.4-5.3	A
2. Sohagpur										
(a) Rungta, Kotma, Jhagrakhand	I-III, Kotma, etc.	5-9	15-30	0.4-0.6	0.001-0.009	34-40	7740-8465	79-84	4.8-5.2	A
(b) Churcha-Kutkona, etc.	II-V	2-4	15-25	0.3-0.6	0.002-0.005	33-40	8220-8440	85-87	4.9-5.2	C-D
3. Chirimiri	I-III	5-7	12-20	0.3-0.4	0.005-0.016	36-38	7750-8100	80-83	4.8-5.2	A
4. Bisrampur	Pasang, Patpahari, etc.	5-9	14-18	0.4-0.6	0.004-0.015	35-38	7600-8100	80-83	4.2-4.8	A
5. Korba	Jatraj, Ghordewa, etc.	6-9	15-35	0.5-0.8	0.005-0.016	32-41	7780-8170	81-84	4.2-5.3	A
6. Lakhanpur	—	7-10	15-20	—	—	35-38	7300-7600	78-81	4.2-4.8	A
7. Ib-River	Ib, Rampur, Lajkura, etc.	6-9	15-35	0.5-0.7	—	32-40	7400-7800	78-84	4.3-5.1	A
8. Talchir	I-IV	6-8	15-40	0.5-0.7	0.003-0.04	35-45	7830-7940	79-82	4.9-5.3	A-B
Pench-Kanhan-Tawa Valley										
1. Detla West, Rawanwara, etc.	I-III	2-6	15-25	0.5-0.7	0.02-0.05	32-38	7650-8140	82-85	4.8-5.4	C-D
2. Darua, Rakhikole, etc.	II-III	2-5	18-24	8.6-1.0	0.05-0.06	32-38	8520-8710	86-89	5.1-5.5	D-F
3. Pathakera	I-IV	2-4	25-30	0.5-0.8	—	33-40	8500-8790	84-86	5.4-5.8	C
4. Tandsi-Nankharak area	I-III	2-4	20-25	—	—	33-35	8620-8730	87-89	5.3-5.4	C-D
Wardha Valley										
1. Kamptee, Umrer, Pipla, etc.	II-V	7-10	15-30	0.5-0.9	0.01-0.04	35-40	7250-7860	78-82	4.2-4.6	A
2. Mairi, Ballarpur, Ghugus, Rajur, etc.	I-IV	8-11	15-25	0.4-0.8	0.01-0.05	38-45	7220-7750	76-80	4.3-5.1	A

(*Contd.*)

Table 1—*Contd.*

Godavari Valley										
1. Kothagudem, Tandur, Ramagundam, etc.	Salarjung, King, Queen, Ross, etc.	6-8	15-25	0.3-0.7	0.005-0.04	35-40	7300-7950	78-82	4.2-5.1	A
2. Gollet, Lingola, Belampalli	I-IV	5-8	15-30	0.4-0.8	0.01-0.05	35-42	7590-8000	78-83	4.5-5.4	A
				(B) *TERTIARY COALS*						
Assam										
1. Makum, etc.	—	2-3	5-15	2.0-6.0	0.001-0.01	42-48	8000-8500	79-82	5.4-6.0	G-G_3
2. Dilli, Jeypore, etc.	—	4-16	8-20	0.4-8.0	0.01-0.02	45-50	7250-8000	75-79	5.5-63	A-B
Jammu & Kashmir										
1. Kalakot, Jangalgali, etc.	—	0.5-2.0	10-35	0.6-7.0	0.002-0.01	13-17	8380-8730	91-93	3.9-4.2	A
				(C) *TERTIARY LIGNITES*						
Tamil Nadu										
1. Neyveli	—	10-30	5-10	0.5-2.0	0.011-0.002	52-60	6450-6600	70-73	4.6-5.5	—
Gujarat										
1. Panandhro	—	15-35	7-20	3-6	—	50-60	6720-7000	68-72	5.1-5.6	—
2. Umarser	—	10-25	10-18	2-3	0.002-0.004	45-55	6500-7230	68-70	4.5-5.3	—
Rajasthan										
1. Palana	—	25-37	4-8	2-4	0.004-0.02	45-58	6870-7000	72-75	4.5-5.5	—
Kashmir										
1. Nichahom	—	10-25	40-54	0.5-0.9	—	60-65	5500-6500	65-69	4.5-6.8	—

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Table 2—Petrographic characteristics of some Gondwana coals

Coalfields	*Seams*	*Petrographic composition (Visible mineral free basis)*			*Average reflectance in oil (Ro %)*
		Vitrinite (vol.) %	*Exinite (vol.) %*	*Inertinite (vol.) %*	
1	2	3	4	5	6
(A) Prime coking coals					
Jharia	IX-XVIII	35-70	0-2.5	30-65	0.9-1.3
Giridih	Lower and Upper Karharbari	50-60	0-1	40-50	1.2-1.4
(B) Medium coking coals					
East Bokaro	Kargali Bermo,	45-65	1-5	35 50	0.85-0.95
	Karo	35-50	1-3.5	45-65	0.9 1.05
Raniganj	Laikdih, Chanch, etc.	45-65	3-7	30-50	0.85-0.95
West Bokaro	V, VI, VII	35-60	6-12	45-55	0.75-0.90
Ramgarh	VI, VII, VIII	45-60	4-12	38-50	0.7-0.90
Jharia	Mahuda Group	65-85	2.5-10	10-30	0.75-0.85
Jharia	V VIII	25-45	0 1	55-75	1.2-1.5
Pench-Kanhan Valley (Damua, Rakhikole, etc.)	Main seam	57-60	8-10	32-34	0.93-0.96
(C) Semi-coking coals					
Raniganj	Dishergarh, Sanctoria	70-85	4-10	10-20	0.75-0.85
Raniganj	Poniati, Hatnal, Koithi, Burradhemo	70-85	5-10	10-20	0.70-0.85
Sonhat (Churcha Kutkona)	V	40-60	5-10	30-50	0.65-0.75
(D) Non-coking coal					
South Karanpura	Argada, Sirka, Hathidari, etc.	50-70	3-10	25-40	0.6-0.8
Hutar	II	40-45	3-5	50-55	0.4-0.6
Rajmahal	Lalmatia	20-25	2-3	75-80	0.45-0.50
Singrauli	Jhingurdah	70-75	2-5	20-25	0.4-0.45
Singrauli	Turra, Purewa	40-50	5-12	40-50	0.45-0.50
Chirimiri	II, III	35-45	5-8	50-60	0.55-0.65
Bisrampur	Pasang, etc.	25-30	10-15	55-60	0.5-0.6
Sohagpur	Bottom Seam	50-55	7-10	35-40	0.55-0.65
Korba	Jatraj, Ghordewa, etc.	40-45	5-10	45-50	0.60-0.65
Umrer	I, II	35-45	5-10	45-55	0.50-0.55
Talcher	Bottom seam (I)	40-45	5-10	45-50	0.50-0.55
Talcher	Jagannath (II)	60-65	5-10	25-30	0.50-0.55
Pench-Kanhan Valley (Eklehara, Rawanwara, etc.)	III	45-55	8-12	35-45	0.50-0.60
Wardha Valley (Ballarpur, Ghugus, Majri, etc.)	Main seam	25-35	15-20	50-55	0.55-0.60
Godavari Valley (Singareni, Kothagudem, Ramagundam, Tandur, etc.)	King, Queen, Ross, Salarjang, etc.	35-45	5-15	40-60	0.55-0.60

Table 3—Grade-wise and State-wise break up of coal resources in India (figure in million tommes)

Non-coking coal

State	*Proved*								*Indicated*	*Inferred*	*Grand Total*
	A	*B*	*C*	*D*	*E*	*F*	*G*	*Total*			
West Bengal	224	1335	2882	754	1143	283	424	6166	11726	8037	25928
Bihar	95	312	633	1106	4849	3299	687	8901	17769	5044	31714
Orisa	129	151	165	251	365	1939	496	1555	18966	19944	34465
Uttar Pradesh	—	—	48	130	151	253	183	685	445	—	1130
Madhya Pradesh	222	761	723	1082	1264	2900	528	7588	9413	4977	21970

(*Contd.*)

Table 3—*Contd.*

Maharashtra	—	80	198	1813	725	74	8	2088	1887	1920	5075
Andhra Pradesh	—	363	1125	1453	436	254	—	5886	2185	3648	9463
Gondwana coal	670	3862	4857	5799	8931	9141	2166	32098	53569	43570	129745
Assam and others		Ungraded (High Sulpher-low ash Coal)						55	264	492	841
Total								32691	53833	44862	130586

Prime coking coal

State	*Proved*								*Indicated*	*Inferred*	*Grand Total*
	Steel Grade I	*Steel Grade II*	*Washery Grade I*	*Washery Grade II*	*Washery Grade III*	*Washery Grade IV*	*More than 35% Ash*	*Total*			
Bihar	260	390	560	750	850	60	213	3623	1558	289	5470

Medium coking coal

West Bengal	—	84	2	8	9	9	12	112	133	43	288
Bihar	5	231	548	1447	1316	3373	2052	8972	8949	693	18614
Madhya Pradesh	—	—	—	45	35	18	55	153	430	98	681
Total	5	315	550	1500	1360	3400	2107	9237	9512	834	19583

Semi-Weakly Coking Coal

State	*Proved*				*Indicated*	*Inferred*	*Grand Total*
	Semi Coking I	*Semi Coking-II*	*Ash more than 24%*	*Total*			
West Bengal	174	285	57	516	814	608	1938
Bihar	—	—	271	271	461	82	814
Madhya Pradesh	26	25	—	51	23	—	74
Total	200	310	503	838	1298	690	2826
Grand Total				46389	66201	45875	158465

Note 1. Resources estimated for seems 0.5 m and above in thickness and up to 1,200 m depth; 2. Grade-wise break up of reserve tentatively worked out at CMPDI.

9. Jhilimili (35 sq km)
10. Chirimiri (75 sq km)

(ii) Coalfields where more than 50 per cent detailed exploration completed:

1. Raniganj (650 sq km)
2. East Bokaro (60 sq km)
3. Pench-Kanhan (250 sq km)
4. Pathakhera (40 sq km)
5. Kamptee (60 sq km)
6. Johilla (20 sq km)
7. Korba (250 sq km)
8. Singrauli (100 sq km)

(iii) Coalfields where detailed exploration coverage is less than 50 per cent:

1. Rajmahal (35 sq km)
2. Hutar (35 sq km)
3. North Karanpura (135 sq km)
4. Chanda-Wardha (130 sq km)
5. Bander (10 sq km)
6. Sonhat (17 sq km)
7. Umaria/Korar (10 sq km)
8. Bisrampur (40 sq km)
9. Sohagpur (30 sq km)
10. Talcher (125 sq km)
11. Ib River (60 sq km)
12. Lakhanpur (10 sq km)

(iv) Coalfields where detailed exploration yet to be taken up:

1. Auranga
2. Sendurgarh
3. Tatapani-Ramkola
4. Mand-Raigarh
5. Hasdo-Arand

Though it may appear from the detailed exploration coverage statistics and also from the share of proved reserve in total coal inventory that a

lot more detailed exploration is required to be carried out to bring the resources under 'Proved' category, yet the coalfield-wise position would reveal that the coverage is quite high in the case of the developed coalfields having infrastructural facilities and also in the areas where the exploitation could be done economically. Broadly, it can be concluded that the proving so far done is quite adequate to meet the coal demand up to 2000 AD or even little beyond 2000 AD. However, it is necessary to prove more resources for the purpose of selection of blocks on least cost option basis and also to provide more lead time for development of mine beyond 2000 AD.

So far the detailed exploration has been mostly confined to 300 m depth horizon because of the fact that most of the existing and projected mines (up to 2000 AD) would be tapping resources within this depth. In future, CMPDI would extend its detailed exploration activity to upgrade the yet unexplored resources available within 300 m depth particularly, in virgin coalfields where infrastructural facilities are not available now like Auranga, Hasdo-Arand, Mand-Raigarh, Sendurgarh, etc. The exploration activity would also extend to tap the resources up to 600 m depth in developed coalfields and even up to 1,200 m depth for proving coking coal and superior grade non-coking coals in Jharia, Raniganj and East Bokaro coalfields.

CONCLUSION

Gondwana coals are generally inferior in nature and contain high percentage of ash because of their inherent nature and also due to existence of number of dirt bands within coal seams.

There is an acute shortage of coking coal (particularly direct feed prime coking coal) and low ash (less than 19%) noncoking coal in the country. These two types of coal together constitute only about 6 per cent of the total coal resources of the country. With the emphasis on extensive detailed coal exploration that is being conducted all over the country, a substantial portion of 'Indicated' and 'Inferred' resources are expected to be brought under 'Proved' category, yet no major change is expected in the proportion of superior grade coals except with only some chance findings. The deficit of such types of coal is expected to be more in future with adoption of large scale machanised mining and stress on opencast mining for achieving greater output. Further, because of inherent high ash content, these coals generally do not respond to economic beneficiation and washing. To overcome such situation in future, it is worthwhile to undertake vigorous studies on technology front to accommodate more and more inferior grade coals in place of superior grade coals both in industries as well as in power plants.

The Gondwana coals because of their basic inferior nature render the exploitation difficult at depth on economic consideration. As such, more emphasis should be given in future to upgrade yet unproved coal up to 300 m depth which accounts for about 63 per cent of the total coal estimated within this depth.